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The Public Lighting Tables of the American Meter Company will be found in the page advertisement of that Company.

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[OFFICIAL NOTICE.]

May Meeting, Society of Gas Lighting.

OFFICE OF THE SECRETARY, May 2, 1895.

The May meeting of the Society of Gas Lighting will be held at the works of the Nassau Gas Light Company, Kent avenue and Cross street, Brooklyn, N. Y. at 3 P.M., May 9th.

FRED. S. BENSON, Secretary.

[OFFICIAL NOTICE.]

May Meeting, Guild of Gas Managers.

OFFICE OF THE SECRETARY, May 2, 1895.

The May meeting of the Guild of Gas Managers will be held at noon, May 11th, in Young's Hotel, Boston, Mass.

A. K. QUINN, Secretary.

Notice of Meeting of Texas Gas and Electric Men.

AUSTIN, TEXAS, April 20th, 1895.

To the Managers, Superintendents and other Officers of the Gas and Electric Companies of Texas: Gentlemen—In response to a circular letter sent out some weeks ago relative to an organization of the Texas gas and electric men, on lines similar to the "Ohio," "Western," "American," and other well known organizations of lighting men, the gentlemen mentioned below have expressed their approval of the move, and join in a call for a meeting. Several have written at length expressing the most hearty approval of the move, and urging that each officer of a gas or electric company, and especially those connected with the smaller companies, be invited to attend and take part in the preliminary as well as permanent organization.

All interested in the gas or electric business are cordially invited to attend our meeting, and as it will probably be deemed wise to arrange for associate members, those wishing to do so may join as associate members.

The meeting will be a strictly business affair—no banquets, excursions, or "blow-outs" of any description; but we all expect to have a thoroughly enjoyable time, nevertheless.

Membership fee will be small, annual dues not burdensome, and expenses must be kept at a minimum.

Arrange to be with us at the first meeting at Houston, Texas, May 22, 10 A.M., "Mason's Hall," Mason block, corner Main street and Rusk avenue. Or, if you can not be present, send in your application for membership, that we may know that you wish to be identified with us.

Many favored Houston and May as the place and time for meeting, and the very low excursion rates, on account of Confederate Veterans' Re-Union (one fare for round trip, with maximum of $5 within the State), makes it especially desirable to meet there.

[Here follow the names of the signers to the number of 20, representing as many lighting companies of Texas.]

[OFFICIAL NOTICE.]

Eighteenth Annual Meeting, Western Gas Association.

OFFICE OF WESTERN GAS ASSOCIATION, NEW ALBANY, IND., May 1, 1895.

To the Members of the Western Gas Association: The 18th Annual Meeting of the Western Gas Association will be held at Pittsburgh, May 15th, 16th and 17th, 1895, and will be called to order by the President, Mr. I. C. Baxter, at 10 A.M., Wednesday, May 15th.

The Monongahela House has been selected as the headquarters for the members, and the meeting of the Association will be held in a suitable room contained therein. A rate of $3 per day has been obtained for those attending the meeting.

The Executive Committee met at Pittsburgh, last February, and selected the following papers to be presented to the Association:

"Metal Tanks for Gasholders," by Mr. Alten S. Miller, Long Island City, N. Y.

"The Advantage of the Metric System for All Calculations," by Mr. Geo. H. Harper, Altoona, Pa.

"Acetylene," by Mr. F. L. Slocum, Pittsburgh, Pa.

"Recuperative Furnaces, as Applied to Bench Firing: Their Operation and Results," by Mr. J. A. Faux, Pittsburgh, Pa.

"Some Experience with Foul Gas in Holder," by Mr. Jas. T. Lynn, Detroit, Mich.

"Ammoniacal Liquor, with Special Reference to the Universal Saving of Same, by Gas Companies," by Mr. Geo. Osius, Detroit, Mich.

"Natural Gas as a Pioneer for Artificial Fuel Gas," by Mr. Donald McDonald, Louisville, Ky.

"Handling and Storage of Oil by Gas Companies," by Mr. D. J. Collins, Chicago, Ills.

"Best Method of Introducing Gas Engines," by Mr. C. B. Case, Milwaukee, Wis.

"Incandescent Gas Lighting," by Mr. S. M. Highlands, Clinton, Ia.

"Wrinkle Department," edited by Mr. Geo. T. Thompson, St. Louis, Mo.

The Central Traffic Association, Trunk Line, Boston Passenger Committee and Southern Passenger Association have granted rates of 1½ fare for the round trip, conditional on 100 certificates being presented to the Secretary for indorsement. The territory of the Central Traffic Association is bounded on the east by Pittsburgh, Salamanca, Buffalo and Toronto; on the north by the line of, and including points on the Grand Trunk Railway from, Toronto to Port Huron; thence via Lakes Huron and Michigan, to the north line of Cook county, Ills.; on the west by the west line of Cook county and the Illinois and Mississippi rivers to Cairo, including Burlington, Keokuk, Quincy, Hannibal and St. Louis; and on the south by the Ohio river, but including points on either side of that river.

The Trunk Line territory is as follows: From Niagara Falls, Buffalo and Salamanca, N. Y., Pittsburgh, Pa., Bellaire, O., Wheeling, Parkersburg and Charleston, W. Va., and points east thereof, except in New England. The names of the roads making the reduction are as follows: Addison & Pennsylvania; Allegheny Valley; Baltimore & Ohio; Baltimore & Potomac; Buffalo, Rochester & Pittsburgh; Camden & Atlantic; Central, of New Jersey; Chesapeake & Ohio; Cumberland Valley; Delaware & Hudson Canal Co.; Delaware, Lackawanna & Western; Elmira, Cortland & Northern; Fall Brook Coal Co.; Fonda, Johnstown & Gloversville; Lehigh Valley; New York Central & Hudson River—Harlem division excepted; New York, Lake Erie & Western; New York, Ontario & Western; New York, Philadelphia & Norfolk; New York, Susquehanna & Western; Northern Central; Pennsylvania; Philadelphia & Erie; Philadelphia & Reading; Philadelphia, Wilmington & Baltimore; Rome, Watertown & Ogdensburg; Western New York & Pennsylvania; West Jersey; West Shore; Wilmington & Northern.

The Boston Passenger Committee territory is from points on the following roads: Boston & Albany; Boston & Maine; Central Vermont; Concord & Montreal; Fitchburg; Maine Central; New York & New England; New York, New Haven & Hartford; Portland & Rochester.

The Southern Passenger Association is composed of the following Companies: Alabama Great Southern; Alabama Midland; Atlantic Coast Line; Atlantic & Florida; Atlantic & West Point; Charleston & Savannah; Central Railroad, of Georgia; Cincinnati, New Orleans & Texas Pacific; East Tennessee, Virginia & Georgia; Georgia Railroad; Georgia Pacific; Georgia Southern & Florida; Jacksonville, St. Augustine & Indian River; Knoxville, Cumberland Gap & Louisville; Louisville & Nashville; Marietta & North Georgia; Memphis & Charleston; Morristown & Cumberland Gap; Nashville, Chattanooga & St. Louis; Pennsylvania; Port Royal & Augusta; Richmond, Fredericksburg & Potomac; Savannah, Florida & Western; South Carolina; Southern Railway Company; Western & Atlantic.

All persons attending the meeting will purchase a first class ticket at starting point, paying full fare for same, obtaining from agent a certificate stating that the person whose signature appears on same has purchased at full tariff fare one first-class ticket to Pittsburgh, which certificate, after it has been signed by the Secretary of the Western Gas Association, and a representative of the above Passenger Associations, who will be in attendance at our meeting, will entitle the holder thereof to one-third fare returning home. This reduced rate privilege extends also to wives of delegates.

All persons availing themselves of the reduced rates will apply to agent 30 minutes before the departure of train. Tickets in accordance with above arrangement can be purchased on and after Saturday, May 11th, and are good, for return trip, on or before Tuesday, May 21st. All agents do not have a supply of certificates, but they may be obtained by request, if notification is made in time. Those parties outside the territory embraced by above four Passenger Associations can obtain reduced rates of 1½ fare for the round trip by purchasing tickets to nearest point within above territory, and from there purchasing a ticket to Pittsburgh No refund of fare can be expected because of failure of the parties to obtain certificates.

There will be an exhibit of gas appliances, to which all manufacturers are invited to contribute. Any information, as to space and place of exhibit, can be obtained from Mr. F. L. Slocum, President of the Gas Engineering Company, of Pittsburgh. It is important that exhibitors apply for space at once and complete their arrangements.

This year we meet in new territory, adjacent to which are many Companies whose officials are not members of the Western Gas Association. We hope that many will embrace this opportunity to become members. The Secretary will be pleased to give those desiring to become members any information wanted, and to mail them copies of the Constitution and By-laws.

The Question Box is now ready to receive inquiries, and those obtained before the meeting will be published, so that all may come prepared to answer them. The Secretary will be pleased to have a number of questions sent him. A cordial invitation is extended to members of other Associations to attend our meeting, and it is hoped that many will avail themselves of the opportunity to be present.

The meeting of the Board of Directors will be held Tuesday, May 14, at 10 A.M., for the transaction of such business as may regularly come before it. The Directory is composed of the following gentlemen: E. H. Jenkins, J. W. Stratton, W. M. Eaton, James Forbes, Wm. McDonald, Geo. T. Thompson, Irvin Butterworth, Robert Young.

The Committee of Arrangements announce a river excursion for Friday, May 17th, to Homestead. The ladies who may be present will be well cared for; everything will be done to make their stay in Pittsburgh pleasant and enjoyable.

Assurance has been given by the Managers of the Monongahela House that they will be able to care for all who may attend; but it is always advisable to secure rooms in advance. Should any not be able to find at the Monongahela House just such accommodations as might be desired, the Duquesne and other good hotels near by are open to receive guests. It will add much to the success of the meeting, however, if all are housed under one roof.

The following Questions have been received: 1. Does the candle power of the gas affect the size of flames, and in what proportion, pressure and burner being the same? 2. What is the best way to prevent the sweating of show windows of gas lighted storerooms in winter time? 3. In cases of introducing gas into houses which have not been piped, has any attempt been made to obviate the necessity of tearing up the floors or of disfiguring ceiling, first, by using a special kind of pipe; or, second, by inclosing common pipe in suitable moulding? 4. Has anyone had experience heating an office or house with furnace in which artificial gas was used as fuel? 5. Does the Welsbach burner produce as much heat, light for light, as an ordinary batwing burner?

JAS. W. DUNBAR, Secretary.

BRIEFLY TOLD.

THE END OF THE STRIKE IN THE SHOPS OF THE AMERICAN METER COMPANY.—In our issue of March 25th we reported that the men employed in the New York and Philadelphia shops of the American Meter Company had ceased to work, the men having "gone out" because of an order issued by the "Union" to which they pay allegiance—and, incidentally, dues. The disagreement between the Company and its employees did not arise from inadequate payment for their labors, nor for overtasking them in respect of the time they were obliged to labor. Quite to the contrary, the men admitted that the Company was eminently fair to them in each of these respects. In our initial notice of the disagrrement, we said, "The men have absolutely no reason for their action that would be listened to for a moment by anyone who would seek to justify them;" and in proof of that assertion we here give a summary of their grievances. First, the Company was directed to give employment to none other than "Union men" in its Burlington (N. J.) branch; second, that the practice of giving contracts to outside parties to make indexes be discontinued; third, that no sort of work, in connection with meter making, that can be done in the Company's shops, shall be done outside of said shops. Of course, there was much more in their manifesto than the mere summary here given, but the summary is an accurate statement of their grievances. The men also threatened "to procure legislation" in Pennsylvania which would prevent the Philadelphia municipal gas works from purchasing any gas meters that had not been made in their entirety in the State of Pennsylvania. The men also resorted to boycotting tactics, an amusing feature of the latter being their appeal to gas consumers of this city to send a postal card, on which was printed the following, "Please call and take out my meter. I want one of some other make than the American Meter Co."—to the Companies which supplied them gas. Further, some of the men appeared before the Committee of the State Senate that is "investigating" the conduct of the office of State Inspector of gas meters in this city, and gave testimony that was ridiculously imperfect to say the least; and that they will regret many times when in reflective mood. To close our reference to the unfortunate (*i. e.*, to the men) happening, we have only to say that the strike was declared "off" on April 25th, and that the men are now more anxious for work than they were six weeks ago to shirk it. The strike was utterly indefensible.

ANOTHER HUGE GASHOLDER.—On Wednesday last a contract was concluded between the proprietors of the Mutual Gas Light Company, of this city, and Messrs. R. D. Wood & Co., of Philadelphia, under which the latter will construct a 4-lift holder on the northeast corner of Avenue D and 12th street, the vessel to have a capacity of something in excess of 4½ million cubic feet. It will replace the nest of four small holders now rising over the point noted. It will rest in a steel tank. This is the way the artificial lighting interests of New York seem to be going on. The Edison Illuminating Company is increasing its bonded debt, while the Gas Companies are putting hundreds of thousands of dollars (out of surplus) into plant enlargements.

PERSONAL.—Mr. Hill, a clever representative of the Messrs. Dick, Kerr & Co., of London and Kilmarnock, whose double-acting gas engine is being put on this market by the American Gas Engine Company, of Philadelphia and Fort Wayne, arrived here from England some days ago. He will remain in the country some weeks, and every Yankee gas man who meets him will meet an affable, capable and reliable member of an important branch of our allied industries.

The Gas Engine.

At the annual meeting of the American Society of Mechanical Engineers, held in Society's house in this city, the topic for debate was the "Gas Engine." Mr. Reeve, in opening the proceedings, said:

The status of the gas engine, as the status of any other thing whatever in the world, depends entirely upon the surrounding conditions. The status of the gas engine to-day is what it has been forced to be and what it has been allowed to be by the general commercial and engineering conditions of the world. The status of the gas engine, therefore, is the status of the power question of the world, and the importance which the gas engine takes in the field depends as much upon the condition of other forms of power as it does upon the condition of the gas engine itself. It comes into competition only with those forms of power which are applicable to almost any locality or set of conditions; and, aside from gas power, steam power is almost the only other occupant of that class of prime movers.

The condition of steam power engineering has very rapidly altered during the past few years—at any rate within the past 10 or 15 years. The steam engine started off as the forerunner, really, of the factory. Perhaps the factory started first on water power. But practically the factory and the steam engine grew up together; and the idea that we, nearly all of us, have carried in our minds of a commercial manufacturing plant driven by any power was a set of tools driven by a central motor through the medium of a line of shafting and a number of belts. That scheme of industrial works grew in size and importance until it had reached tremendous proportions, and in certain lines of industry it still survives and will continue to survive in still larger sizes and on a still more important scale. But for the vast majority of industries, those species of manufacturing which involve a varied number of processes and departments and involve the production of a comparatively complex commodity—such, for instance, as the building of steamships or railway cars, or the complicated machines involving wood work and iron work and steel forging work, the modern factory is a collection of factories. The various factories may be merely departments, merely various rooms in one building or on one floor. But, at any rate, the factory now consists of a large number of departments and those departments are quite distinct. They often run entirely independently, have separate foremen or superintendents, run different hours and have different classes of labor. In some, labor is a small item and power is larger. In others, power is a small item and labor is the principal feature. All these various conditions make it almost impossible for such an establishment to be driven by one central prime mover. In the first place, distance of transmission comes in and consequent losses. In the second place come in varying conditions. Every engineer knows that no piece of apparatus can work well under varying conditions. We have therefore seen grow up in the last few years the modern industrial works, in which the power has to be transmitted quite a distance and subdivided among a large number of different sorts of tools. This, of course, was first attempted by shafting and belting or by rope drives. But it is evident that the loss by transmission in all those various transitions and distances of transmission are very great. Consequently, we have seen other schemes tried. First came the subdivision of the steam engine itself into a large number of units, and we have only to look about us in our large factories to see steam driven plants where the power is furnished from the central boiler plant to anywhere from 10 or 12 to 70 different engines scattered all over the works—sometimes 20 or more in one room. Sometimes the losses in steam transmission are under average conditions less than for shafting and belting. Of course no cast iron rule can be given for all conditions. But the subdivided steam plant has come in to stay. Of later years, superseding the subdivided steam plant, came in, first, compressed air and then electrical transmission and subdivision of power.

I have given this *résumé* of the changes of the power question to show that the problem of the present is economical transmission of power, not economical development of power.

Now, those of you who have spent any time on the problem of the subdivision of power and its transmission have seen that none of the systems heretofore provided satisfy the question. They all involve tremendous losses in transmission. They all involve heavy first cost, heavy expenditure for generating transmission and redeveloping plant at the other end. Now, the present status of gas power in this country or any other, and also of its immediate promise for the future, depends upon this statement of the problem in this part—that gas power offers the ideal solution for the subdivision and transmission of power, the mechanical difficulties being for the time lost sight of. In other words, let us suppose that a large industrial plant requiring, say, 1,000-horse power subdivided into, say, 50 different units, which are utilized at various points in different buildings on different floors at different speeds for different hours during the day, under different conditions of varying and steady load; suppose that in such a plant as that we install a 1,000-horse power generator or its equivalent, and then lead from it or from the holder to a large number of gas engines large central gas mains, it is evident that the first cost is for below that of any system, with the possible exception of the subdivided steam plant, where our boiler plant corresponds to our generating plant, our steam mains to our gas pipes, and our steam engines to our gas engines. But there is one great advantage which a gas plant has over a steam subdivided plant in point of operation, and that is that in the steam subdivided plant, no matter how large a proportion of the load be off, the central generating plant must be run and the fixed charges of running can not be altered. Steam must be kept up, the boilers must be kept hot, the stack, if there be one, must be kept hot, and the labor must be there to take care of the whole plant. I have myself tested one factory in which for a large proportion of each day the efficiency for the transmission of the power between the boiler plant and the work was 5 per cent., simply because the whole plant had to be kept going in order to move one small department. With the gas plant that entirely disappears. Your gas generator works for a certain number of hours a day on whatever load or capacity is best suited to produce maximum economy. During those certain number of hours a day the generator makes gas and stores it in the holder.

The gas generating plant is entirely unconscious of the consumption of power provided it be large enough to fulfil all demands. The consumers of power, the foremen of different departments, are as unconscious as is the generating plant of the consumption of power. They simply know that all they have to do is to turn on their gas and start their engine. They may run 24 hours in a day while the gas generator runs eight, provided the total maximum production of the gas generator is large enough to cover the whole output of power. The comparison between such a gas plant and any plant relying upon transmission and subdivision of power, by compressed air, or by electricity, or by any scheme wherein the power is first developed by the steam engine and then converted into another form and then converted back again, a comparison between the gas power plant and any such plant as that is really hardly possible from the economical standpoint. The operation of any such gas plant would be incomparably more economical than that of the compressed air or the electrical or the hydraulic system of transmission of power. You will notice that I have entirely left out of the question the mechanical side of it, which I purposely wished to do. But for the merely commercial side there is an absolutely unlimited field for the development of power and its transmission and subdivision in industrial works by means of the gas generator and the gas engine.

The next leading argument for any plant of that sort for division of power is that in every industrial works the supply of power or steam—the supply of power is made to correlate with the other portions of the work. To be more plain, perhaps, in nearly all of our large textile mills in New England, and in a great many other lines of industry, the steam is used as much and sometimes more for heating purposes, and boiling and dyeing, than it is for power. In fact, the important promoter of steam power in New England, where it has proved an indispensable auxiliary of water power, is the fact that the steam had to be had anyhow. That is true also of compressed air plants. There are a great many forms of factory where compressed air is indispensable for blowing, furnishing draft, cleaning and innumerable purposes to which it can be applied, and in a great many plants compressed air is used to transmit and subdivide power where no other system would be tolerated, simply because the compressed air must be there, the mains must be there, and it is a great deal better to use it for power. The same thing applies to electricity. Those factories relying on the electric current entirely for light may often bring the power question into an entirely secondary importance. If they have got to have their central engines and generators and mains for the production and distribution of light, and if they need light more than power, then of course the electrical transmission of power is the thing, without any regard to the general arguments against it. But this same factor of the correlation of the system of transmission of power and the system of transmission of other forms of energy needed in the works applies also to gas. In fact, the gas producer has reached its present state of perfection largely owing to the fact that gas is the most economical form of fuel for a large number of industrial devices where exact temperatures and exact control of temperatures have to be had. In all those plants the power may again become secondary to other purposes in the factory, and in those plants

where generators have already been installed for the purpose of supplying fuel gas, the gas engine follows as a natural sequence.

The reply to this side of the discussion is that the mechanical difficulties have not yet been overcome; that the gas engine to-day, after having had spent on it of the best energy in the line of mechanical engineering which the world has been able to produce for some 30 years, is still more crude in a great many mechanical features than was the steam engine of a century ago. It is still very heavy. In nearly all of the devices only one impulse is received by the flywheels for every two revolutions; in the case of the single acting engines only one is received, so that the flywheels are heavy. The regulation, as a rule, is accomplished by simply dropping out a certain proportion of the impulses instead of varying their strength; and the necessity for the ignition of the charge in a minute fraction of a second has led until very recently to extreme uncertainty in the matter of ignition and also on the question of perfection of combustion. That last is not so marked a feature, because even with poor combustion the gas engine is an exceedingly economical prime mover. But the mechanical difficulties still stand in the way of the accession of the gas engine to the proper field in which it belongs—that is, the universal factor for the production and transmission and subdivision of power in industrial works.

At the risk of being considered rather superficial in skimming over this subject, I will take one step into the future and say that while gas engines have hitherto been almost entirely run with illuminating gas, yet already there has been considerable done in the way of supplying gas engines with gas from special producers built just for that purpose. There has also come upon the field the incandescent gas burner—that is, it has just begun to attract wide attention as being an established fact. These two coupled together—first, that the gas engine can be run much more economically upon producer gas, not illuminating gas, than it can upon illuminating gas; and second, that there is a means attained of producing illumination by a non-luminous gas—lead us to the surmise that the near future will see the distribution of energy—all energy—which is derived from coal in the form of a non-luminous, cheaply produced fuel gas; that this gas will be relied on entirely for power, for lighting where gas lighting at all is permissible, and where it is not, where the electric lighting is needed, that electric light will be produced through the medium of gas engines, and that this same gas will be used for all sorts of fuel and heating purposes.

Professor Hutton read the following discussion, communicated by Professor Wm. S. Aldrich, of West Virginia University:

Some of the chief difficulties to the extended introduction of the gas engine have been gradually removed by the improvements in methods and apparatus for the manufacture of producer gas on a small yet economical scale. In this as in other branches of engineering the law of supply and demand operates to mutual advantage, and isolated gas engine plants are rapidly coming to the front. On the other hand, for the distribution of power from a central plant to greater or less distances gas offers peculiar advantages. There are practically no losses in distributing the gas in pipe lines except leakages which can affect the economy of the distribution. Losses of pressure and temperature changes do not in the least affect the economy of the gas engine at the end of the line. Therefore the distribution of power by gas and its utilization in gas engines scattered over a widely extended area may come to be a rival of some of the other methods, and the facility of storage and use of gas for heating are additional advantages.

It seemed doubtful for a long time whether gas engines could be made and economically managed in large units; but the present use of the same up to 300 horse power, and the contemplated manufacture of gas engines of 500 horse power and upward, leaves no room for serious doubting. But it is open to discussion whether there is the same inherent gain in economy in the use of large gas engines as in the case of steam engines. Of course, on the general principles of power production, large units are more economical, per horse power, than small units. Nevertheless, there is scarcely an argument advanced for the use of large steam engines that cannot be similarly advanced in the case of gas engines.

In the matter of arrangement of gas engine cylinders, there is undoubted preference manifested for the vertical type and in pairs, with cranks at 180° apart. Four cylinder or quadruplex gas engines are being seriously considered, to gain an additional advantage along the same lines as the two-cylinder or duplex type—namely, a greater number of explosions per revolution, and consequently an increased opportunity to control the supply and explosions according to the load.

As rotating or rotary gas engines have been suggested, it may be well to note some of the advantages arising from using the explosions of the gas in much the same manner as the Pelton wheel utilizes the steadily applied impact of the water. The losses due to connecting-rod mechanisms are eliminated; the highest speed may be obtained and controlled, especially to be desired in direct connection to dynamos; multiple discharge jets (or explosion pockets) may be arranged, as in the Pelton wheel; the force of the explosion may be most directly utilized in a tangential manner; the internal friction will be reduced to a minimum; the best opportunities presented for regulating against the rapidly varying loads of electrical supply service, and probably a greatly increased economy in the use of gas.

In matter of speed regulation, gas engines have had an unenviable reputation, more due to the inherent difficulties of control than to any lack of inventive ability along this line. Always single-acting, frequently run at slow speeds, and sometimes with rapidly varying loads, it is not difficult to understand that during one or more strokes the supply of gas may be entirely omitted and the unusually heavy flywheel drawn upon to meet the periodic variations in the supply of energy.

Respecting the conditions of maximum economy in the use of gas, it has been found that there is a certain best load for any given engine running at a given speed, at which load there is the least expenditure of gas per horse power per hour. In this way it is possible to establish a very satisfactory basis for rating gas engines; that is by their most economical performance. If gas engines could be tested and the curves of performance plotted as in the case of turbines sent to the Holyoke Testing Flume, the whole gas engine business would at once be placed on as satisfactory and substantial a basis as is now the case with turbines. The establishment of such a gas engine testing plant is urgently needed. It would go far toward giving much needed additional encouragement to the well-directed efforts in the development of the gas engine as well as serve to forestall fruitless attempts in the same line.

Losses in the Steam Engine.

[A paper read by Mr. William A. Bole, before the Engineers' Society of Western Pennsylvania.]

It is a matter of common observation that heat, by acting upon matter of almost every kind, causes it to expand. Heat, acting upon the vapor of water, is the source of power in the steam engine. The water or the steam is the vehicle of heat in this case. In order not to confuse the responsibilities of engine and boiler, in discussing the subject of losses, it is to be borne in mind that an engine uses *steam* and not *fuel*.

It is fairly well understood to-day that there is a direct and positive relation between heat and mechanical work. That a given amount of heat, expanded, is capable of producing (if not wasted in the process), a definite amount of work, and if the process be reversed, exactly this same work expended will yield the original amount of heat. By the compression and expansion of gases, this mutual convertibility is proven.

Experiments made some 50 years ago by Joule, and confirmed by many experiments since, give a fixed value in terms of work to the thermal unit, or heat unit, as it is commonly called. This thermal unit is defined as that quantity of heat required to raise the temperature of one pound of pure water 1° F., at or near the point of water's maximum density—about 39°. The value in foot-pounds of one such thermal unit is 772. This value was determined by an apparatus in which the energy of a descending weight was used to agitate a definite quantity of water in a closed vessel, protected from outside influences, and the consequent rise of temperature of the water afforded a ready means to measure the value of the work so done. The resultant, called by name Joule's equivalent, indicates that a weight of one pound descending through 772 feet would, by this apparatus, raise the temperature of one pound of water by 1°.

The unit of work in this country and Great Britain is the foot-pound; 33,000 foot-pounds of work, if done in one minute of time, is the conventional unit of horse power. The steam engine and all other prime movers are built for the purpose of developing horse powers. The aim of their designers is to produce a horse power with the minimum cost of construction, greatest simplicity of mechanism, and least expenditure of the working fluid.

From the standpoint of pure theory, a horse power should be obtained from the expenditure of $\frac{33,000}{772}$, or 42.74 heat units per minute, and 60×42.74, or 2,564.4 per hour. One pound of dry steam at a pressure of 100 pounds absolute, has about 1,181 heat units above 32° F.

If all the heat in this pound of steam could be converted into work, then a horse power could be obtained by expending $\frac{2,564}{1,181}$ or 2¼ pounds per hour. How does this compare with engines in actual practice? The best authenticated record of steam engine performance of which I am aware is the case of a triple-expansion engine, condensing, running under 125 pounds steam pressure, with all the accessories of economy, such as steam-jacketed cylinders and receivers. The engine, under test at Providence, R. I., is claimed to have produced an indicated horse power for 12.9 pounds of steam per hour.

The celebrated Pawtucket pumping engine, built by George H. Corliss, as tested by Professor Denton in 1889, used 13.62 pounds of steam per indicated horse power per hour.

The best performance of steam engines of the more ordinary types may be put down about as follows:

Corliss engines of single cylinders, non-condensing, 26–30 pounds.

Corliss engines of single cylinders, condensing, 19–21 pounds.

Single valve automatic engines, 30–32 pounds.

Ordinary throttling engines, with such governors as Judson's, Water's, Gardner's and the like, 35–50 pounds.

Slow moving, full stroke, pumps, without cut off, as high as 100 pounds.

These figures are intended to represent fairly the best reliable results for the respective classes. Owing to defects of design, improper adjustments, or severe wear at critical points, each of these engines mentioned may consume vastly more steam than the figures stated. The standard of performance for every machine should be the best it can do when in good condition, properly loaded and properly operated.

Referring back to the theoretical standard of Joule, it will be seen that the best cases on record show a consumption of steam of about six times what this standard would establish. In other words, the very best steam engines extant seem to have a thermal efficiency of about 16 per cent.

In endeavoring to locate the reasons for this waste, it may be said that the one all important source of this loss lies in the nature of the vehicle employed, steam; and as we are limited to this as the only practical means of producing a motive power, it would seem to our present knowledge of the subject as a difficulty impossible to surmount. No very great advance on best present practice may be looked for.

The total heat of one pound of steam at a pressure of 100 pounds absolute is given as 1,181 heat units above 32° F. The latter point is the freezing point of water. Let us take one pound of water at that temperature and apply heat to it. The first 180 heat units which it receives are available to raise its temperature to the boiling point, when it begins to emit vapor, if under atmospheric pressure only. The next 966 heat units are expended in changing its form from a liquid to the gaseous condition of steam, and in displacing the atmosphere to make room for its increased volume, but without increasing its pressure above atmosphere. Thus (180 + 966 =) 1,146 heat units are already expended on one pound of steam, which is still at atmospheric pressure. By the expenditure of 1,181 heat units, is produced one pound of steam at 100 pounds absolute pressure. These figures show the value of steam of high pressure, there being so much more available heat in the latter case, although there is not much difference in the total expenditure necessary to produce it.

The pressure of steam is that part of its energy which is available for use in the steam engine, and after its pressure has been judiciously expended in the cylinder, the heat which it still contains is not capable of being used for the production of power. On this account the engine is charged with what it cannot possibly utilize, and this makes the apparent loss so great. Properly speaking, the engine rejects this unavailable heat, and does not consume or waste it. If the rejected heat be utilized, as in some instances, for heating purposes and for other manufacturing processes, then the engine is properly charged with only the difference between the heat received and the heat rejected, and viewed in this light it can be, and often is, a very efficient machine. The best that the engineer can do is to take the volume of steam thus formed, and by expanding it to the greatest advantage in the cylinder, use up all its expansive energy as far as he may, and then reject the residue, its capacity thus spent, to the condenser or to the atmosphere. The undoubted energy which this rejected steam contains is not of such a nature that the engine can utilize it.

There are limitations to the degree of expansion which may advisedly be employed in using this pressure of steam. If not expanded at all, the loss of available energy will be very great. If expanded too far, in an effort to get "everything there is in it," the loss by internal condensation in the cylinder will be very great, and a proper mean must be sought for.

Steam formed in the presence of water, as we are all familiar with, is called by the name "saturated steam." This is to distinguish it from superheated steam, which is quite a different thing. Saturated steam does not mean wet steam, as I used to think. Suppose we make 1 pound of dry saturated steam of a pressure of 100 pounds per square inch from 1 pound of ice-cold water, and, for ease of computation, suppose the water is boiled in an upright cylindrical vessel whose cross section is 1 square foot. By reference to the tables we will find that this 1 pound of water in this cylinder of 1 foot area will occupy a depth of about 12-62.4, or about 3-16 inch. Put a fire under it, after loading it with a free-moving piston whose weight is 85.3 pounds per square inch, which, augmented by atmospheric pressure, means 100 pounds per square inch, or a total weight of 14,400 pounds. As the fire burns the water absorbs heat and the temperature rises, as the thermometer will show. The volume of the water varies only to a small extent. After the water has acquired 298 heat units, and the thermometer shows a temperature of 328° F., the boiling point for this pressure is reached, and if more heat is applied the weighted piston begins to rise because steam is being formed. If sufficient heat is applied to evaporate all the water, it will absorb additional 883 heat units to convert it from the liquid state called water into the gaseous state called steam, and this much of the heat, about three-quarters of it, is what is called latent heat, because the thermometer does not detect it. The heat of evaporation is a more correct name for it. This 1 pound of water must now be 1 pound of steam, for it has lost none of its weight. It now occupies a volume of 4.3 cubic feet, and as the area of the vessel is 1 square foot the piston has been pushed up 4.3 feet. In doing this the steam has done work measured by the product of force and distance equals $14,400 \times 4.3 = 61,920$ foot-pounds.

Joule's equivalent applied here, or $\frac{61,920}{772} = 81$, shows that 81 heat units have been expended in doing external work, and the difference between the total latent heat, $883 - 81 = 802$ heat units, has been expended in doing the internal work of evaporation. The external work, 81 heat units, produces the volume, and the 802 heat units, still latent, seem to produce only the change of state.

Suppose this steam to be used in a supposititious engine, whose cylinder walls, heads and pistons have no capacity for heat, and which has no clearance spaces whatever. If steam is used without expansion, or full stroke, as usually expressed, then in such case 81 heat units per pound of steam will be utilized, and the consumption of such an engine per horse power will be about 32 pounds of steam per hour, $\frac{33,000 \times 60}{61,920} = 32$, and at the end of each stroke the cylinder full of steam would be exhausted at the original pressure, 100 pounds absolute.

In order to more economically utilize the steam we will imagine that with the same supposititious engine we will use the steam expansively, and after the piston has advanced a certain proportion of its stroke will cut off communication with the boiler and allow the steam already admitted to expand against the piston and increase its volume as its pressure falls. This engine, it must be explained, is an imaginary engine, because it is impossible to find such materials out of which to build it, and it cannot be constructed without some waste space or clearance. In real engines there are limits beyond which it is not practical to carry expansion, the reasons for which are given later on. In the best practice steam is not cut off earlier than about 20 per cent. of the stroke, and it expands from the point to the end of the stroke.

If consumption of 31½ pounds of steam per horse power hour was consequent on using steam full stroke, then this expansion of the steam should reduce the consumption to about 12.8 pounds per horse power hour $\left(=\frac{31.5}{2.5}=12.8\right)$. The pressure of steam will have fallen at the end of stroke to $100 \div 5 = 20$ pounds absolute, or 5.3 pounds above atmosphere, less a proper correction for the disappearance of some heat which has been converted into work. It is during this period of expansion that a portion of the latent heat of the steam is given out and converted into work. As this latent heat cannot be released except by the liquefaction of a part of the steam, condensation from this cause does occur in the cylinder, and the exhausted steam from our imaginary cylinder is wet.

If the foregoing is correct, we have witnessed the process of making 1 pound of steam out of ice-cold water, and have seen that 1,181 heat units were spent in producing it. We also saw that it is possible to utilize 81 heat units in the *external* work of the steam before expansion be-

gins, and about 120 more as expansion progresses, a total of about 200 heat units. It follows that 1,181 — 200 = 981 are rejected to the exhaust and thus only about one-sixth of the total heat is converted into work, while the other five-sixths still remain as heat, unconverted, and, as far as we now know, unconvertible.

Here is the principal source of waste in the steam engine. If it were practicable to carry the steam through 20 expansions, to a terminal pressure of about 10 pounds *below* atmosphere, then the consumption of steam per horse power should be about 9 pounds.

Thus far we have dealt with an ideal cylinder, because ideals are useful in pointing out the right direction and in assisting in our analysis, even though we know they are themselves unattainable. Real cylinders being made of cast iron, have properties which modify matters greatly. Iron has a great capacity for heat, and whereas our ideal cylinder was non-conducting, our real cylinder was far from it. In order to communicate steam to our real cylinders, we must have entrys or ports, also free room between pistons and cylinder heads, and thus clearance becomes a factor, as this space must be filled with steam, as well as the real working part of the cylinder. In a non-expanding ideal engine the consumption of steam per horse power would be increased directly by the percentage of the clearance. In such an engine, working steam expansively, such loss is reduced, and in real cases still further reduced by compression during the return stroke. Also in our real engine there is an unavoidable back pressure during the return stroke, which reduces the available horse power and thus impairs the efficiency. . . . When the admission valve of an actual engine is opened, the entering steam meets the walls of the cylinder which have just been exposed to the relatively cold exhaust. The cylinder walls rob the entering steam of a part of its heat and greedily absorb it. Condensation is thus caused and water is formed in the steam and on the walls. As the piston advances, additional surface is exposed and the action continues as long as the valve is open and pressure is maintained at or near boiler pressure. In the indicator diagrams this is not detectable. As a given quantity of the entering steam is thus in part condensed and contracts its volume, new steam from the boiler supplies the volume, and there is no observable loss of pressure in the cylinder from this cause. But it is certain that instead of one pound of dry steam admitted at the cut-off point, as the volume would seem to require, we have admitted a very great deal more, by weight, perhaps, twice as much, part of it already converted into water. After the admission valve is closed the expansion begins and the pressure falls as the volume increases. A part of this water already formed in the cylinder now re-evaporates, and adds to the volume of the expanding steam, but in so doing robs the cylinder walls of a part of their heat. At the end of the stroke, the exhaust valve is opened and the cylinder is put into communication with the atmosphere, or with the condenser for the return stroke. The temperature of the steam has now fallen greatly and the walls of the cylinder give up to the cold exhaust the greater part of the heat which they stole from the entering steam, and prepare to go back empty-handed, as it were, to steal more.

The cylinder, therefore, in its conduct systematically and continually robs Peter to pay Paul, the role of Peter filled by the live steam ; that of Paul by the exhaust. This action is dependent in its extent upon several considerations, chiefly these : Time of exposure, which depends upon the speed of the engine. Ratio of expansion, which determines the range of of temperature in the cylinder during the working stroke. Temperature of the incoming steam depending on its pressure. Temperature of exhaust, due to back pressure, atmospheric exhaust pressure, or condenser temperature. It also is dependent upon the relation of cylinder surface to cylinder volume, and thus is greater in small engines than in large ones. It is, therefore, advisable to design an engine so that it may complete its stroke in the shortest practicable time, all things considered. The ratio of expansion, at least in one cylinder, must be kept within limits to avoid great extremes of temperature. Compounding, or serial expansion in several cylinders, may be employed to reduce the losses caused by these variations of temperature, while making the most of steam's expansive properties.

A proper relation should exist between boiler pressure and the work to be done in connection with the character of the mechanism by which it is to be done. The steam should escape from the cylinder with the least possible resistance to its exit.

Loss of pressure in the cylinder due to insufficient steam pipes is a loss of available energy, so also ports that are too small or circuitous to readily conduct the steam in or out of the cylinders. Steam pipes are frequently too small, although it is possible to make them too large. Exhaust pipes are often too small, but in this case it is practically impossible to make them too large.

Leakage is a constant source of loss in every engine, depending, of course, upon its designs, the workmanship of its construction, and wear. Valves and pistons may be constructed so as to be fairly tight when new, but they will wear to a leaky condition, and it is not always possible to detect it by indicator diagram. In the case of small engines they may be blocked to prevent moving, and the cylinders filled with steam to test for leakage of valves as well as pistons, but this is not often practicable in large engines, and is, I think, very seldom resorted to.

It has been said that 1,181 heat units are required to convert 1 pound of ice-cold water into steam of 100 pounds pressure absolute. In actual practice it is not common to use feed water of such temperature. The exhaust steam escaping from our real engine contains a great deal more heat than we are able to utilize in the cylinder. We can pass the feed water which our boiler requires through this escaping steam, using one of the many forms of heaters, and can thus pre-heat the feed water up to almost the boiling point under atmospheric pressure if the engine is non-condensing. If surface enough is provided it is possible to obtain about 210° F. In such a case the gain, over 32° F., or 178 heat units, will not be required of the boiler, and we shall expend only 1,181 — 178 = 1,003 heat units to make 1 pound of steam from 1 pound of water.

It is possible to go a step further, and by passing this heated water through the escaping gases from the furnace through an apparatus usually termed an "economizer," to heat the water up to nearly the temperature of that in the boiler, and thus reduce still further the amount of heat which must be supplied in the boiler. Such apparatus, of course, is exposed to the deposit of soot from the fire, and has to be continually scraped to remove this deposit and keep the surfaces exposed, so as to take up the heat of the escaping gases into the feed water.

The only correct way to arrive at a knowledge of how much steam an engine is using, and to ascertain its efficiency, is by actual test. All other methods are simply guesswork. Many a large and underloaded engine has been thought economical, and many a small and overloaded one has been condemned as wasteful when the facts were directly the opposite. Both of these conditions are, of course, inimical to economy, and the engine must be of proper size if the best results are to be obtained. As the loads on many engines fluctuate between wide limits, as, for instance, in rolling mills, street railways, etc., an engine may be too large for the load one minute and too small the next minute. In the first instance excessive condensation in the cylinder prevents economy, and in the second an absence of expansion produces the same effect. In such engines economy of the highest order is an impossibility. The best results are always obtained where the load is practically constant, as in water works, pumping engines, cotton mills and the like, and in marine practice.

The testing of a steam plant is ordinarily made to embrace the weighing of the feed water before its admission to the boiler, the weighing of the fuel burned, and the ash or incombustible remaining, the temperature of the feed water, that of the steam and its pressure, and the temperature of escaping gases. The engine is indicated at frequent intervals, and the average horse-power developed is thus obtained. The quality of the steam supplied is tested by calorimeter, and the amount of entrained water thus determined goes to the credit of the engine. It is, of course, understood that steam is not taken from the boiler for any other purpose than to drive the engine under test.

I repeat what was said earlier, viz., the engine uses steam, not fuel. Therefore, in considering the performance of the engine, we are chiefly concerned with the total feed water in pounds, the percentage of moisture in the steam, the average horse-power developed ; all these reduced to a time basis, and usually the time unit is an hour. Such a test requires considerable time, often 24 hours in important cases, and may require several men to check up the various quantities involved. In looking after the engine's interests, it must be ascertained that neither the boiler, nor the feed water heater, nor any of the pipes leak, or if they do, the rate of leakage per hour must be obtained by test, and deducted from the total feed water. The net outcome of such test will be the number of pounds of dry steam consumed by the engine per horse-power per hour.

A much simpler way of testing the steam consumption of an engine is practised by some builders, and the method is equally accurate, or perhaps more so, than that just described, because simpler. In such case, the engine may take its steam supply from the same boiler as several other engines. The exhaust from this engine is conducted by a separate pipe to a surface condenser, which is supplied with cooling water, and the resulting condensation is caught and weighed. The engine is indicated as before, and the calorimeter test made for dryness, or rather wetness, of the entering steam. The hourly condensa-

tion, less the percentage determined by calorimeter, divided by the average indicated horse-power, gives the vital quantity, the hourly consumption of dry steam per horse power.

A rather important item is the friction of the engine, and this increases with the complication of parts. The triple and quadruple engines, with their accessories, air pumps, circulating pumps, multiplicity of pistons, valves, and stems, their numerous crank pins and journals, must have a large and often indeterminate amount of internal friction, which is a slight offset to the increased economy per indicated horse-power developed in the cylinders. Economy in the use of steam is a critical thing, and very exacting in its demands. The seeker after her must comply with her own terms, and it follows that one must look after every step in the process of generating and using steam in order to do any creditable work in this line.

There is, in many quarters a disregard of what may be called a steam engine's rights, and the lowest price determines what goes in. It may not be amiss to state what is the significance in dollars and cents of the various types of engines, and their respective degrees of economy, mentioned at the beginning of this paper. Assume 10 hours daily service, which, with the preparatory firing at morning and noon, together with banking of fires over night, may be safely put down as equal to 12 hours daily service. Assume coal at 6 cents per bushel at the coal bin, equal to about $1.60 per ton, and assume 300 working days to the engine each year. One more assumption, that one pound of coal, actual weight, will evaporate nine pounds of water into dry steam, under actual conditions, thus:

An engine using 10 pounds steam per horse-power per hour, would cost for coal, $3.15 per year single turn, or $6.31 double turn for each horse-power.

An engine using 20 pounds steam per horse power per hour, would cost for coal $6.31 per year single turn, or $12.62 double turn for each horse power.

An engine using 30 pounds of steam per horse power per hour would cost for coal per year $9.46 single turn, or $18.93 double turn, for each horse power.

An engine using 40 pounds steam per horse power per hour would cost for coal per year $12.62 single turn, or $25.24 double turn, for each horse power.

An engine using 50 pounds steam per horse power per hour wou'd cost for coal per year $15.78 single turn, or $31.56 double turn, for each horse power.

Many of the large engines in this city do run 24 hours per day, and as few if any of them have boilers evaporating under actual conditions more than 7½ pounds water per pound of coal, then, omitting the first two cases above—

An engine using 30 pounds steam per horse power per hour will cost for coal $22.72 per horse power per annum.

An engine using 40 pounds steam per horse power per hour will cost for coal $30.30 per horse power per annum.

An engine using 50 pounds steam per horse power per hour will cost for coal $37.87 per horse power per annum.

If these figures are not in error, they should point out the necessity for judicious selection of engine and boiler, for as the cheaper and smaller engines of to-day can be bought from $8 to $10 per horse power, it will appear from the foregoing that such an engine can eat its own head off four or five times per year, or, otherwise expressed, the coal burned in three months of double turn duty will cost as much as the original price of the engine. In localities where coal costs from $5 to $10 per ton instead of $1.60, these figures have a still deeper significance.

The suggestion has been made that the waste heat of large steam plants be made a bye-product and be sold for heating purposes. I am not aware of any such plants in actual operation, unless in the case of such office buildings as use a steam plant for electric lighting, and use the engine's exhaust for heating their own building. It would not seem to be an impossible thing to take up this waste heat of a large central station into a body of water, and by a proper system of circulating pipes conduct the hot water through the dwellings of the neighborhood, and thus compete with the coal dealer or the vendor of natural gas.

Nature seems to have fixed certain barriers to the limits of temperature which can be practically employed. The lowest temperature is limited by that into which the waste heat of the engine may be rejected, usually the atmosphere, and the highest limit that which the strength of materials and their capacity to resist deterioration will permit of.

In cases where boiler pressure is carried to 200 pounds per square inch, and the exhaust is carried into vacuum of 26 inches, the two boundaries are about reached—certainly the lower one is. This is the chief reason for the shortage. It goes without saying that the vast difference between best practice and the worst will be diminished as users of engines become more awake to the facts and demand better efficiency; and they will of course be prepared to pay more attention to the needful details and expend more money for economical apparatus.

Underwriters' Rules.

[A paper read by Mr. William A. Anthony before the 96th meeting of the Am. Institute of Electrical Engineers.]

A recent controversy in relation to inside wiring for incandescent lighting has suggested to me the importance of bringing out a full and free expression upon the subject from those whose experience gives them the best right to speak; and I venture to bring the matter before the Institute in the hope that it may provoke such an expression as may have some influence in determining the character of any changes in the rules for construction that may be proposed, or in fixing the interpretation to the rules now in force. The present rules are, of course, the result of a precess of evolution, and I think everyone will admit that the process has been one of progress. In the early days of electric lighting the desire to conceal the wires led to fishing them in between floor and ceiling and between plastered walls, as has been done with electric bell and burglar alarm wires. Fires occured, and were ascribed to the electric wires, sometimes rightfully, but no doubt sometimes wrongfully.

Insurance companies took up the matter, passed rules and appointed inspectors. Many of the rules were good, some were only an annoyance to the construction companies. Different boards adopted different rules, and often the inspector was a law unto himself.

Wishing to assist in securing uniformity, and feeling that electrical engineers, who have to do with the practical work of electrical installation, are best qualified to frame rules for electrical construction, the National Electric Light Association, in 1890, appointed a committee to take the matter in hand, and upon the report of this committee, in 1891, adopted a series of rules, which, with some amendments adopted at later meetings, may be assumed to represent fairly well the consensus of opinion among the electrical fraternity as to what constitutes a safe electrical installation.

Rules, substantially the same as those, have been adopted by the National board and various local boards of fire underwriters, and are the recognized rules in force at the present time.

The object of all rules is, first, to secure a safe and permanent installation; second, to provide for the repair or renewal of conductors in case of failure. It may be said that from the standpoint of the insurance companies the first is the only object, but surely conductors so installed that they can be easily overhauled and replaced in case leakage is discovered are safer for the very reason that a fault is likely to be repaired before any serious damage has occurred.

When highly insulated wires, whose insulation resistance was measured in megohms per mile after immersion in water for weeks, came into use for electric lighting plants, it was natural to suppose that they could be put anywhere, and would last indefinitely. They were put in all sorts of inaccessible places—on the beams before floors were laid, in partitions before plastering, on the lath with iron staples to be covered with mortar. Some such circuits are no doubt in existence to-day as perfect in insulation as when first put up; but numberless cases of failures of insulation occurred, and experience shows that such a construction is entirely unreliable. Then came the interior conduit, which it was assumed would serve both as a mechanical protection and as an insulator; but it was found not to be entirely reliable in either capacity. It was not impervious to moisture, it was subject to damage by nails, saws and chisels, It was found necessary to prescribe that wire of the highest insulation should be used in it, and that it should not be drawn in until all danger from mechanical injury was passed. Then came the brass armored conduit; but that was not nail proof. Now we have the iron armored conduit, and it remains to be seen whether this will fulfill all requirements.

It has come to be pretty well recognized that no mode of electrical construction is absolutely proof against failure at some point, and that form of construction is best which affords the smallest chance for injury or depreciation, and offers the greatest facilities for repair or renewal in case of failure. There has been a uniform progress in the direction of greater safety and better facilities for repair, from the time when wires were put anywhere, to be covered by floors or mortar, or built into brick walls, to the iron-armored conduit which is offered to-day. To be sure, the cost of the installation has advanced, and the iron

armored conduit presents difficulties when alternating currents are employed. To me it seems that the advantages gained are worth the cost, and the difficulty with alternating currents disappears if the two conductors are placed in one conduit. To this I can see no possible objection when the conduit is iron armored.

In view of the fact that we cannot be absolutely certain that failures in insulation will not occur in any given installation, it seems to me that the foundation principle of all rules for the placing of conductors should be accessibility. Further, no conductor should be placed where its position or its relation to other conductors in any part of its length is unknown. This means that raceways must be provided, into which conductors may be drawn and from which they may be removed at pleasure, such raceways to serve as adequate protection from mechanical injury; or the conductors must be placed in moldings which are themselves accessible, or they must be supported by cleats or insulators in plain sight.

I believe that past experience would warrant the adoption of a rule that would require the use, for concealed work in buildings of fireproof construction, where conductors must be carried up steel columns, over steel floor beams, in brick partitions, or in plastered walls, of a raceway or conduit, equal in its ability to afford mechanical protection to that known as iron-armored conduit, so installed that conductors could be drawn in or out at any time.

And now a word as to the controversy that suggested this paper:

A conductor has been put upon the market which consists of a standard Habirshaw wire with its covering of rubber and braid, having woven upon it two additional coverings of extra heavy braid. This additional covering, which is tightly woven on, and from which the wire can no more be removed than from its original covering of rubber and braid, the maker, by an extraordinary stretch of language, calls a tube, and claims for it the advantages of the conduit tube prescribed in the insurance rules. It goes without saying that this wire affords no means of replacing a damaged conductor, and therefore has not that advantage of the conduit. As to mechanical protection, it certainly is not superior to the unarmored conduit, and it has not the advantage that the conductor can be left out until the danger of injury is passed. As to insulation against moisture, the added coverings do not improve it, the insulation being entirely due to the rubber covering which is inside of all the braids.

And yet I have just learned that the New York Board of Fire Underwriters, on March 20, passed the following resolution:

Resolved, That the Superintendent be authorized, until further notice, to approve the use of the Attix tube and wire, when equal in quality and insulation to the samples submitted to this Board and tested, under the same conditions where tubing would be permitted, provided that there is no splicing or tapping of the wire, but that its introduction shall be in all cases by the loop system; that in new buildings, when necessary to carry it between floors and plastering, it shall be through holes bored in the beams, not less than two inches apart, a single conductor in each hole, out of the reach of nails; and in old buildings, where necessary to carry it within the reach of nails, it shall be protected by some device from perforation; and provided further that the wire and tube be carried intact into the cut-out boxes, and that in no case shall the outer covering be removed before introducing the core wire into the cut-out box.

It will be noticed that the wire is called a "tube and wire," when it is no more a tube and wire than the Habirshaw which forms its basis. The tests referred to show that, after immersion in water, or being imbedded in plaster, the insulation resistance was 20 megohms per mile. But the Habirshaw wire, without the Attix covering, would have shown the same. What then is the propriety of confining the operation of this resolution to the Attix wire? Why not permit the use of any good highly insulated wire under the same conditions?

It seems to me that this resolution is one of those reversions to an ancestral type which we find in all evolutionary development, which is off the general line of progress, and which is destined soon to become extinct.

The Flame-Extinguishing Properties of Carbon Dioxide and Nitrogen.

The London *Journal* says: At a recent meeting of the Nottingham Section of the Society of Chemical Industry, Dr. F. Clowes, Professor of Chemistry and Metallurgy at University College, Nottingham, gave an account of a series of experiments carried out by himself and Mr. M. F. Feilmann, with the object of ascertaining the minimum proportions of carbon dioxide and of nitrogen which, when mingled with air, are extinctive to the flame of various combustible gases and liquids. An abstract of the communication, with a report of the remarks to which it gave rise, appeared in a subsequent number of the Society's *Journal*, from which the following particulars have been taken:

Professor Clowes explained that the method of experiment consisted in mixing the measured volumes of air and of the gas by the motion of a light ball, so as to avoid the solvent action of water on carbon dioxide. After proving that the method yielded mixtures accurately in the desired proportions, the trials were made by introducing the experimental flame into mixtures of air and gas, which were varied in proportion until the flame was immediately extinguished, but continued burning for a short time in a mixture containing 1 per cent. less of the extinctive gas. The influence of the products of combustion was eliminated by this procedure. It was found that the size of the flame had no influence on the extinctive proportions. The following table summarizes the average results obtained:

Combustible Substances Burnt.	Extinctive Proportion of Carbon Dioxide Added to Air. Percentage Added.	Percentage Composition of Mixture. O : ($N+CO_2$).
Alcohol (absolute)	14	18.1 : 81.9
Do. (methylated)	13	18.3 : 81.7
Paraffine (ordinary lamp oil)	15	17.9 : 82.1
Colza oil with equal volume of petroleum	16	17.6 : 82.4
Candle	14	18.1 : 81.9
Hydrogen	58	8.8 : 91.2
Carbon monoxide	24	16.0 : 84.0
Methane	10	18.9 : 81.1
Ethylene	26	15.5 : 84.8
Coal gas	33	14.1 : 85.9

Combustible Substances Burnt.	Extinctive Proportion of Nitrogen Added to Air. Percentage Added.	Percentage Composition of Mixture. O : N
Alcohol (absolute)	21	16.6 : 83.4
Do. (methylated)	18	17.2 : 82.8
Paraffine (ordinary lamp oil)	23	16.2 : 83.8
Colza oil with equal volume of petroleum	22	16.4 : 83.6
Candle	22	16.4 : 83.6
Hydrogen	70	6.3 : 93.7
Carbon monoxide	28	15.1 : 84.9
Methane	17	17.4 : 82.6
Ethylene	37	13.2 : 86.8
Coal gas	46	11.3 : 88.7

The results obtained show: (1) That carbon dioxide exerts a uniformly more powerful extinctive effect than does nitrogen. This may possibly be partly due to its high density, which renders the movement of air to feed the flame sluggish. (2) That the different wick-fed flames are extinguished by a strikingly uniform proportion of the extinctive gas. These flames were noticed to gradually diminish in size and die down, evidently owing to the supply of combustible material to the flame being diminished in amount by the reduction in temperature of the flame. (3) That the extinctive proportion for the various gas-fed flames varied widely, and did not appear to be deducible from the composition and chemical nature of the gas which was burnt. The extinctive proportion for a coal gas flame was much larger than that for a wick-fed flame, while the extinctive proportion for the hydrogen flame was extraordinarily high.

The gas-fed flames increased in size during the process of extinction, instead of diminishing as in the case of the wick-fed flames. This appeared to be due to the fact that the supply of combustible was maintained independently of the flame itself, and that the flame had to increase its surface in order to obtain the supply of oxygen necessary for its combustion in air containing a diminished proportion of that gas.

Attention was directed to the practical advantage derivable from the large proportion of carbon dioxide (58 per cent.) necessary to extinguish the hydrogen flame. The author had described an ordinary miner's safety lamp, in which a hydrogen flame could be burnt at will instead of the oil flame for the purpose of delicate and accurate gas testing. It was now found that by burning the flame of hydrogen beside the oil flame in parts of the mine where the atmosphere might contain large amounts of carbon dioxide, the extinction of the oil flame was not attended with loss of flame in the lamp, since the hydrogen flame never suffered extinction, and served to rekindle the wick in fresh air after the oil-flame had been extinguished by a foul atmosphere. This had proved to be a great convenience to exploring parties in a mine after a fire or an ex-

plosion; and it was the direct consequence of the resistance of the hydrogen flame to extinction by carbon dioxide.

Professor Clowes went on to say that recent experiments, carried out by Mr. J. R. Wilson on rabbits, had thrown considerable doubt upon the statement that the proportion of carbon dioxide in the air which extinguished the flame of oil or a candle was irrespirable. This, however, was a matter to be decided by physiological experiments. But it might be taken as finally established by the experiments he had just described that about 15 per cent. of carbon dioxide was at once extinctive to ordinary illuminating wick-fed flames, although 33 per cent. was requisite to at once extinguish a flame of coal gas, while a hydrogen flame did not suffer extinction until 58 per cent. of carbon dioxide was present in the air.

In the course of the discussion on the paper, Mr. G. J. Ward remarked that in his case they were in the habit of burning under their boilers waste gas from the blast-furnaces. Roughly speaking, the gas contained 30 per cent. of carbon monoxide, 6 per cent. of carbon dioxide, 4 per cent. of hydrogen and hydrocarbons, and 60 per cent. of nitrogen. Approximately, 85 per cent of air was required to burn the mixed gases. After the addition of air, the mixture would contain about 89 volumes of carbon dioxide and 11 volumes of oxygen in every 100 volumes of non-combustible gases—a mixture which was extinctive for carbon monoxide, according to Dr. Clowe's experimente, and yet combustion took place under their boilers. He asked if Dr. Clowes could explain this. Mr. R. L. Whiteley did not agree with the argument that, because a rabbit could live in air which contained a certain large percentage of carbon dioxide, a human being could also live. He thought that animals accustomed to living above ground should be experimented upon, if anything like satisfactory conclusions were to be arrived at. Dr. Stafford said there seemed to be some considerable difference of opinion with regard to this matter. Recent experiments tended to show that they had been accustomed to over-estimate the dangerous qualities of carbonic acid gas as a constituent of respiratory air. Considerable quantities of carbon dioxide might be added to air before it became fatal to an animal breathing it. In this connection, Dr. Whitelegge had spoken of carbon dioxide in respiratory air as the "harmless index." It would appear that the use of oil-stoves for warming rooms, in place of open fires, was not so objectionable as might appear. Providing that the combustion of the oil is complete, the carbon dioxide produced did not appear to be harmful—fairly adequate ventilation being allowed for. Recent research seemed to show that the deleterious properties of expired air lay more in the volatile organic material given off than in the carbon dioxide expired. Mr. F. J. R. Carulla referred to the power of the lamp to keep a flame alight in atmospheres where the oil-flame went out. This seemed to him to be an extremely valuable discovery.

Replying to the remarks, Dr. Clowes said that the conditions under which the furnace gas mentioned by Mr. Ward was burnt, were sufficiently unlike those of his own experiments to account for the difference in the result. Part of the extinctive gases was mixed beforehand with the combustible gas; and the combustion of hot gas took place in a heated space, which would tend to maintain the flame. He remarked also that hydrogen was present as well as carbon monoxide. The conditions were therefore entirely different from those under which he had worked; and the conclusions arrived at in the paper were not applicable to Mr. Ward's case.

An English Gas Manager's Views on Public vs. Private Trading.

At the final winter meeting of the Saltcoats (England) Debating and Literary Society, the speaker for the evening was Mr. J. N. Myers, manager of the local Gas Company, who addressed his hearers on the subject of "Public versus Private Trading." He introduced his remarks by saying that the old exhortation not to take thought of our food, drink or clothing was wholly discarded in the speeches and writings of the political and reasoning school known as the Manchester economists, as well as in the orations and essays of the plausible and romancing advocates of socialism, inasmuch as the first article of belief of the former is to "buy in the cheapest and sell in the dearest markets, and thereby maintain a trading warfare against the world, as the great underseller of other nations," while the gospel of the latter is the equal distribution of existing wealth. He then went on to say that those who reflected on the contentions of both schools would see that they preached widely different sermons from that contained in another different exhortation, addressed to the Corinthians, to "let no man seek his own, but every man another's wealth." This text, he said, seemed to him to summarize the entire creed of the two schools of economists; for instead of no thought being given to procuring the necesities of life, the whole trend of present day literature and legislation was to drive home to the masses that their individual thoughts and energies should be devoted to increasing their worldly comforts—the individualists maintaining that this would be best accomplished by individual effort; while the collectivists said the maximum of happiness could only be obtained by municipalizing and nationalizing everything.

Passing to the subject of his paper Mr. Myers explained that he proposed recounting briefly a few thoughts on the question of "Private versus Public Trading," which had been generated in his mind in the course of reading and studying the general and technical literature issued in connection with light, water and sanitary engineering; and he asked his audience to remember that these three branches of industry had so far, been the principal—indeed, almost the only—incidents of municipal management. He then proceeded as follows: "Now the first and most pertinent question is, Has the municipalization of light, water and sanitation led to better management, or proved an advantage to the communities interested? In other words, are the results such that we can say collective or public supervision has been better than individual or private enterprise? I am aware that the great majority of the members of all political parties are at present in favor of the idea that light, water and sanitary affairs ought to be in the hands of municipal or local authorities. They will not be satisfied to see corporations undertake the supply of light and water only. Municipalities must go far beyond such undertakings, and enter into competition with rivals small and great. We see evidence of this spirit in every issue of our local papers. The desire of local busybodies or small politicians to set up business in gas, water or electrical schemes is not founded on anything deeper than sentiment, or sometimes of 'pure cussedness.'"

Dealing further with the question, Mr. Myers said: "The history of gas and water undertakings which have been acquired by local authorities or town councils does not support or strengthen the case of those who maintain that gas or water can be supplied cheaper or more efficiently by public than by private enterprise. The cheapest gas in the kingdom is made farthest from the coal fields by a private company; and I am disposed to think that had the business of the Plymouth Gas Company been acquired by the corporation twenty years ago, instead of selling gas, as they now do, for 43 cents, it would have been 68 cents per 1,000 feet, and the consumers would have been indirectly taxed to provide pavilions for Punch and Judy shows. Those of you who take an interest in parliamentary procedure know that the sole reason admitted by our parliament as justifying the transfer of gas or water undertakings from private companies to town councils is that of expediency. Expediency, I maintain, should be confined to the power of proving that the transfer from a private company to the local authorities ought to result in the public obtaining cheaper light or water. That is the only factor which should enter into the problem. The interest of a town council in acquiring control of the gas or water consists, or ought to consist, in the prospect of securing cheaper public lighting, or of improving the gas or water supply of the town. Now, the words 'It is expedient,' in every parliamentary bill rarely convey the true or actual motive for local public bodies acquiring gas or water undertakings, as the gas works are generally run by municipal bodies to make them 'milch cows' to contribute to the general municipal funds. That is the true motive for the anxiety of municipal and local authorities to get possession of the gas and water undertakings.

There are some good reasons to be advanced for the municipalizing of light and water companies—*e. g.*, these are wholly local industries, export nothing, live upon the local community, can only prosecute their business by making constant use of the streets and abuse of the roadways. I see few objections why, in the interest of health and cleanliness, the management of water and sewers should not be in the hands of the municipalities; "but when a municipality steps outside the straight path of parochial utility, and by a majority (maybe of one) involves the credit, not only of its constituents then existing, but of many future thousands, in purely commercial and largely speculative ventures, such as gas vending or electricity vending, 'a magnificent sample of municipal enterprise' may very well become a piece of injustice." Though gas vending may have, and has, helped the rates in many towns, it has always been an indirect taxation upon the consumers of gas. As good a reason may exist for the municipalizing of bread and milk, or even whisky.

Considering next the subject of the unification of industry under State control, where all men would be reduced to a common level, Mr. Myers said this was an idea which found lodgment in minds of a

poetic and theorizing order; and one would not quarrel very vehemently with them in their advocacy of an equal distribution of wealth, if these "champions of spoilation" were men who had, by their own individual energy and capacity, created any proportionate share of the world's wealth. But the heroes of the doctrine that no man should seek his own, but another's wealth, were generally shallow visionaries. The teaching of the Collectivist appeared to him (Mr. Myers) to destroy or supplant the stimulus to courageous enterprise and tireless energy. The socialistic controllers of municipal ventures owed what little success had attended their efforts to the capable men trained by private companies; but the way in which they haggled over the remuneration of their "captains of industry" did not attract capable men to the service of the community.

In conclusion Mr. Myers said that, in thinking over the *pros* and *cons* of Collectivism and Individualism, it had come home to him that Carlyle's idea of history was to be preferred to that of Macaulay. The Ecclefechan seer preached that this is a world in which little can be known, and very much has to be done. Carlyle was a strong reasoner; and his whole teaching was that a man deserved nothing and that the rights of man were nothing compared to his duties. The Collectivist School, on the other hand, prated about the rights of man, and conveniently left his duties out of their vaporings. The rights of man were, according to their "Gospel of Labor," the right to take a share of rewards and earnings of those who gained wealth while they "biggit castles in the air." He thought they could all do something to save Individualism from cast-iron, barbaric heathenism, and unite it to the Collectivist doctrine to "look not every man on his own things, but every man also on the things of others." They could do unto others as they would have others do unto them; and whatsoever their hands found to do, they could do with all their might. He knew of no other panacea to correct the evils now to be seen around us.

The Legal Aspects of Electrolysis.

[By Mr. Henry C. Townsend, in *Cassier's Magazine.*]

It is, at the present time, a well settled fact that a continuing and serious damage is done to buried gas and water pipes and to the metal sheaths of buried telephone and other cables by the action of electricity as now generally employed by electric railway companies for propelling their cars, and, while efforts are being made to obviate the trouble, the success of the remedies proposed or their suitability for constantly changing conditions is somewhat doubtful so long as the rails are employed as a part of the electric return circuit. It is generally admitted that a complete remedy is found in the use of a return circuit entirely insulated from the earth, such as would be afforded by the use of a double trolley wire; but there is a natural aversion on the part of the street railway companies to such an expedient because of its expense, although it may be seriously questioned whether the deterioration or corrosion of the rails themselves, when buried in the earth and used as a return circuit, is not a source of loss whose magnitude, if fully appreciated, would virtually compel the adoption of this remedy.

The disposition, however, is to palliate the evil, if possible, by improving the conductivity at the rail joints, thereby furnishing so good a path for the return current that the amount diverted to the earth and to buried conductors will not produce a material injury. The injury arising from imperfect bonding had, however, grown to be very great before the extent of the evil had been suspected, and will continue to exist wherever the bonding is imperfectly done or where it may deteriorate.

The question arises on this general state of facts, Upon whom does the responsibility rest for the injuries heretofore accruing, or which may hereafter arise, from the corrosive action of the railway currents? A similar question arose some years ago in controversies between the telephone and electric railway companies. The injury complained of by the telephone companies in these cases was due, not to corrosive action of the railway currents, but to the inductive disturbances upon their pole lines parallel to the trolley wires, and to the presence upon the telephone lines of the electric railway currents passing to earth and thence to such lines.

In the majority of these controversies the courts refused relief to the telephone companies, and it has been suggested that these cases furnish precedents for the disposition of such controversies as may arise from the corrosive action of the railway currents upon buried metal. Their value as precedents is, however, open to grave doubt.

The contention of the railway companies, as advanced in the prior cases, virtually resolved itself into the claim that they cannot be held liable for the injuries caused to neighboring property through the operation of their road by electricity, because their enjoyment of their rights and franchises is in pursuance of legislative authority. But, as said by the Supreme Court of the United States in a similar case, the grant of powers and privileges to do certain things does not carry with it immunity for private injuries which may result directly from the exercise of those powers and privileges, nor is the liability of a company to respond for damages caused by it affected by its corporate character. Its liability for annoyance, discomfort or damage is the same as that of individuals for a similar wrong. Nor is its liability affected by the extent or character of its franchise. Whatever the extent of the authority conferred, it is accompanied with the implied qualification that it shall be so exercised as not to work an annoyance or damage to others, and even if that authority extend expressly to permitting the use of the rail return, the liability for damage caused thereby cannot be escaped, although in some quarters the notion prevails that the railway company cannot be held liable, on the general rule that whatever is authorized by competent authority cannot be treated as a nuisance.

There is, however, a wide distinction between that class of cases in which the act complained of is a public work, done under the authority of the Government by persons deriving no personal advantage, but acting within the best of their skill and scope of their authority, and that in which the act, complained of as having wrought injurious consequences, is done by private individuals and not essentially for a public purpose, but for private emolument. In the one case the execution of the act is a public duty imposed by the Government, and which, having been accepted, must be executed; no claim can lie for consequential damages arising from the execution of that duty. The act of the other is not essentially and only for a public purpose, but mainly for private emolument. The electric railway company, in respect to indivduals or the public, stands in the position of doing an act for its own profit and benefit, the direct and necessary consequence of which is an injury, if the act from which that injury arises is the use or operation of its system by a return through the rails. The act upon which the legal injury is founded is not the operation of the road by electricity generally, but the employment of the specific kind of plant which the company has elected to build and operate, not because the purposes of its character, so far as the benefit of the public is concerned, could be best carried out by that plan of operation in preference to the system which would work no injury, but because it is primarily for its own pecuniary benefit, though attended by a continuing and grave pecuniary damage to the physical property of others.

It cannot be justly claimed that the beneficial uses of the street, so far as the public is concerned, and in respect to the uses for which the railway company becomes the servant of the public, are in any substantial manner enhanced by the employment of the earth or rail return circuit in preference to that other method which was open to the railway company to employ, though at considerably greater expense and, of necessity, therefore, at a diminution of profits. Facility and speed of transportation in the city streets are the primary purpose or benefit in consideration of which railway companies enjoy their franchises to employ the electric current, but no one can safely affirm that this benefit can be accomplished only by the use of that one of the known systems of distributing the electric power which is now generally employed.

The question is, practically, whether the railway company, for its own profit, and not for the benefit of the public interest in the streets, shall be allowed to employ that method of distributing its power, of which the usual and known consequences are to work a serious interruption to the enjoyment of a previously granted franchise in pursuance of which the streets and the earth have been occupied for the operation of a plant in what was, at the time of its installation, a well known and recognized way and was within the corporate powers and grants. There are wrongs or damage for which the law provides no remedy, and it is the general rule that if the owner of property, in the prudent and necessary exercise of his own right of dominion, does acts which cause loss to another, it is, as the law puts it, *damnum absque injuria*. So, too, acts of public agents, within the scope of their authority, if they cause damage, cause simply *damnum absque injuria*.

With some exceptions the general rule is said to be that no person is liable for damages incidentally occasioned to others by the necessary and beneficial use of his own property or of a franchise granted to him by the State; that every man has the right to the natural use and enjoyment of his own property, and if, while lawfully in such use and enjoyment, without negligence or malice on his part, anunavoidable loss occurs to his neighbor, it is *damnum absque injuria*.

On these general propositions a Circuit Court of the United States denied relief to a telephone company, injured by the operation of an elec-

tric railway with a ground return ; but the decision seems to have rested largely upon the erroneous assumption that the use of the ground return was necessary to the enjoyment of the franchise of electrically propelling cars. Even if, however, the use of the single trolley be lawful, the charge of negligence cannot be escaped if the railway company fail to use the best method of bonding its rails, provided that bonding would remove the damage from corrosion, and any damage that could be shown to have resulted from its failure to use the best means in its power would be recoverable.

While the failure to use the double trolley may not, in the opinion of the courts, constitute a reasonable ground for charging negligence in those cases where a telephone company is injured by induction or vagrant currents passing onto its lines and ringing its bells, such a ruling affords no precedent under which the railway company may be held to be relieved of the obligation to use the best rail return after it has elected to adopt that method of enjoying its franchise. But not a few cases are found in the reports wherein a company is held liable for damages caused by acts done within its chartered powers.

A notable one, peculiarly apposite to the matter here treated, is that of a corporation charged with repairing the public streets, and which, in so doing, used rollers so heavy as to injure buried gas pipes. The rollers were economical and well fitted for the purpose, but the repairs could have been effected by rolls which would not have produced the injury. The defendant was held liable for the injury. Here was the case of a public grant to a gas company, enjoyed in a certain way, followed by the grant to another company to exercise a right which, if exercised in one way, would injure the former, but, exercised in another, would not.

In another case the defendant was a corporation engaged in digging a canal. In the prosecution of the work it was found necessary to blast rocks, and the fragments injured adjoining property. For this immediate and direct damage, resulting from an authorized act necessary to the enjoyment of the privilege, the company was held liable.

In still another case a company, under authority of the government to enter a city with its tracks and to construct such works as it might deem expedient for the completion and maintenance of its road, placed its engine repair shops in a position where they interfered with the use of neighboring property, acquired by the plaintiff long before the shop was built. The court held that such authority did not permit it to place its shops wherever it might think proper without reference to the rights of others. The court said :

"Whatever the extent of the authority conferred, it was accompanied by the implied qualification that the works should not be so placed as, by their use, to unreasonably interfere with and disturb the peaceful and comfortable enjoyment of others in their property. Grants of privileges or powers to corporate bodies, like those in question, confer no license to use them in disregard of the private rights of others and with immunity for their invasion."

As to running of the cars in the streets, it held that no one could complain of the incidental inconvenience unavoidably following the occupation of the streets by the cars and the noises attending the running of them. The damages by electrolysis cannot, however, be said to be unavoidable, because there is a plain remedy in the use of the double trolley, the employment of which is not inconsistent with the full enjoyment of all the advantages to the public from electric transportation. Among other instances is the flooding of another's land by a party authorized to build a dam. The authority was held not to carry with it immunity for the resulting damage. So, also, the diversion of the waters of a running stream by the trustees of a city, authorized by statute to provide a water supply for a city, was held actionable.

In another case a railway was adjudged not liable to a telephone company on the ground that the dominant purpose of the streets is public travel and transportation, and the right of the railway company to use improved modes of conveyance was, therefore, superior to the rights of the telephone company. Whether or not this decision be sound, it is obvious that it affords no support for the proposition that the railway company is not responsible for material and direct damage to gas and water pipes.

While the chief use of the streets is for travel, this is not the only use recognized by the law. The laying of water and gas pipe has long been recognized as a necessary use, and may be well held superior in importance to that use which involves the employment of electricity in the particular way which works a damage to the property of others while another way, free from objection, is open to adoption. Claims to immunity for damage, because of superior right, will not, we imagine, avail the railway as defences in any suit brought for a damage that could be proved to result to water or gas pipes from the grounded electric railway return.

In the telephone cases the courts were apparently influenced to a decision in favor of the railway company by the consideration that the injury to the telephone company was in the nature of an inconvenience rather than a direct or material damage—the visible, positive and necessary result of the railway current. The opinion seems to have been that as there was no actual, physical invasion or destruction of property, amounting to a taking, or visible damage, capable of exact ascertainment, therefore, the injury should be treated as consequential and not to be remedied in the absence of fault or negligence in the exercise of the railway franchise. Nevertheless, it is well recognized that a serious interruption to the common and necessary use of property may be equivalent to a taking of it, and so be within the prohibition found in the constitution of most of the States in America that private property shall not be taken for public use without just compensation, and it is not to be supposed that the courts intended to go so far as to ignore that principle, founded on the natural principles of equity.

The damage to water and gas pipes is a continuing and material one, involving a physical destruction of property and practically an invasion of it by a foreign agent or force, called into action and directed to the pipes by the acts of the railway company, and which, like other natural agents, as water, light, heat, is, as Blackstone puts it the case of water, a "wandering thing," only kept in bounds and directed by some positive means applied by the user.

[To be Concluded.]

Utilizing Gases from Coke Ovens.

Le Genie Civil is the vehicle chosen by G. A. Renel for propounding his views respecting the utilization of gases from coke ovens, in the course of which he says :

La Societe des Mines de Carmaux has a battery of 84 coke ovens, and has for some time past been considering the question of utilizing the waste gases. Two solutions were proposed : (1) A complete distillation of the gases permitting the recovery of the bye-products in a marketable form. (2) The use of the heat of the gases to make steam by the employment of a special generator.

The first solution—that is, the complete distillation of the gases—requires the installation of an expensive plant with special apparatus. On the other hand, the simple utilization of the heat presented many advantages. The first cost of the plant was less, and the rest of the apparatus—boilers of an ordinary form or multitubular—could be easily installed, and their management would require no special technical knowledge. The proximity of the St. Barbe mine works, and of the plant for the manufacture of briquettes, which together had 22 boilers in use, permitted the direct use of the gases without heavy loss by condensation in carrying the steam. Finally, the gases being taken only from the parts of the chimney connected with the coke ovens and then passed into the open air, it was believed that the quality of the coke would not be changed, provided the draft of the boiler chimneys was properly regulated.

The second solution of the problem was thus adopted, and after careful comparative study it was decided to use Belleville multitubular boilers, which seem to have all the qualities required by the conditions presented.

At Carmaux there are 84 coke ovens of the Coppee system, divided into 10 batteries, 8 of eight ovens each, and 2 of ten each. Each oven takes a charge of 5 tons of coal to produce 4 tons of coke after 48 hours treatment. The charging is done from above through three openings arranged in the length of each oven. Each line of charging holes is served by a track which runs from one end to the other of the line of ovens. The gases escape by openings placed in the upper part of the oven, pass through flues in the walls separating the ovens, and into the collector of the battery, from which they pass to the chimney. Each battery is separated from the next one by a wall of varying thickness ; at each end also there is a wall of masonry.

The first, or experimental boiler, is placed a little in front of the ovens, in such a way as not to interfere with the movements of the charging wagons and the tracks. A collector lined with refractory material is built in the wall to take the gases near the base of the battery chimney, and carry them to the boiler. There the gases are forced through two openings upon the surface of the tubes of the boilers ; after passing these tubes they escape into an iron chimney placed directly over the boiler. Two dampers or gates, one horizontal and the other vertical, permit the gases to be turned at will into the ordinary chimney battery of ovens and to the boiler. These dampers are placed at a certain distance from the direct current of the flame, in such a way as to avoid

the destructive action of the fire. The Belleville boiler used is provided with an automatic feed arrangement. It has five elements, giving with the steam drum a heating surface of 82 square meters in all. Openings made in the lower part of the masonry surrounding the boiler permit the entrance of air to be regulated so as to give at all times a complete combustion of the gases.

Recently some trials were made extending over six consecutive periods of 24 hours each. The eight ovens were drawn, two at a time, in order that there might be as nearly even a quantity of gases delivered to the generator as possible during the period of 48 hours. The results obtained were as follows: Quantity of water vaporized per hour averaged 1,317 liters, the maximum quantity being 240 liters, and the minimum 890 liters. The average temperature of the ovens was 1,223° C. The pressure in the boiler varied from 9 to 15 kilos. The steam produced is used: 1. During the day at one of the engines driving the Briquette Works, at a constant pressure of 5 kilos. It has taken the place of two boilers heated by coal formerly used. 2. During the night it is used at the St. Barbe Works, where it is mixed with steam from the battery of ordinary boilers.

The coal coked gives about 25 per cent. of volatile matter. The average quantity of water vaporized per square meter of heating surface per hour is 14.6 kilos, but this figure has been increased to a maximum of 22.2 kilos. The results noted have given much satisfaction from the point of view of steam-making and the working of the boiler. Assurance has also been given that the coke is not altered in any way. The single boiler, as erected and tried, has proved so successful that the company proposes to put up additional boilers in order to use completely the heat of the gases from the 84 ovens, and the work has already been begun on these new boilers. Moreover, the St. Barbe works do not use all the steam, and part of it will be taken for a central station requiring about 1,200 h. p. This station will enable the company to operate a number of machines in the mine, and will also provied an economical light for the shafts and passages.

This interesting installation furnishes an excellent example of the results which can be obtained by utilizing the heat now generally lost in coke oveds.

ITEMS OF INTEREST FROM VARIOUS LOCALITIES.

THE Long Branch (N. J.) *Record*, of April 26th, said that articles of agreement had been signed by the stockholders of the Long Branch Lighting Company, which convey the gas and electric light plants of Long Branch to the New York Gas Improvement Company of this city. This means that Messrs. Geo. M. Curtis, Geo. H. Baker, H. E. Gawtry, H. C. Fannestock and J. A. Garland are now in complete control of the gas and electric lighting supply of Long Branch, West End, Elberon, Hollywood, Norwood, Monmouth Beach and North Long Branch.

AT the annual meeting of the shareholders in the Rome (N. Y.) Gas Light Company, the Directors chosen were: J. D. Higgins, H. G. Utley, T. H. Stryker, Calvin Petrie, W. R. Huntington, J. G. Bissell and T. W. Singleton.

THE proprietors of the Parkersburg (West Va.) Gas Company and of the Parkersburg Electric Light and Power Company have agreed to work in harmony hereafter. This is a pity, for the gas company had all the best of the position.

THE Hackensack (N. J.) Gas Light Company has bought out the local electric lighting concern, the purchaser virtually naming its own terms.

AT the quarterly meeting of the Board of Directors of the Meriden (Conn.) Gas Light Company it was determined to order a reduction in the selling rate. The new schedule calls for a net price of $1.65 per 1,000 cubic feet. The old net rate was $1.80.

THE following determination was reached about a fortnight ago by the Board of Aldermen, of Buffalo, N. Y., the appended preamble and resolutions, introduced by Alderman Smither, having been unanimously adopted:

"*Whereas*, In the contracts between the city and the electric light companies the quality and candle power of the light to be furnished are carefully expressed; and

"*Whereas*, In addition to the amount paid by private individuals for the lights the city annually expends nearly $300,000 for lighting the streets, and

"*Whereas*, The Board passed resolutions or ordinances, on January 16, 1893, February 26, 1894, March 26, 1894, and September 19, 1894, directing the Board of Public Works to cause the gas and electric lights to be tested, and report the result, and on January 28, 1895, said Board was authorized to expend the sum of $600 for the purchase of apparatus for this purpose; and,

"*Whereas*, As to the gas, no such test has been reported since June, 1893; therefore, be it

"*Resolved*, That the Board of Public Works is hereby requested to report at the next regular session of this body why said tests have not been made."

A CORRESPONDENT forwards the following from Baltimore, under date of April 26th: "The trial of the third suit against the Consolidated Gas Company, of Baltimore, because of the explosion in the cellar of premises, No. 1210 East Monument street, which cause was on trial in the Superior Court, resulted in a verdict for $437.22 for the plaintiff, John J. Crocker. Plaintiff sued for damages to his saloon and fixtures. This verdict is certainly a queer one, when it is remembered that suits on the same ground, brought by M. T. Sullivan, owner of the property, and Mrs. Letitia Staengler, who was personally injured in the explosion, were both decided in favor of the Company. The Company's defense in all these cases was that the explosion was not caused by illuminating gas that escaped from the pipes, but that it resulted from the ignition of the vapor of gasoline which had been thrown on a pile of coal in the cellar. The Company will appeal the case."

EVERYTHING points to a termination of the long continued opposition at Memphis, Tenn., betweeen the New Memphis and the Equitable Gas Light Companies of that city! At any rate, President Katzenberger, of the Equitable claims to have solved the problem, although he should not be given undue credit for his cleverness on time account in this instance, since he and his associates could have settled it long ago on the basis of the present agreement.

At the annual meeting of the Columbus (Ohio) Gas Company the report of the doings of the Company for the year was eminently satisfactory to the shareholders inasmuch as it showed a substantial increase in the output and the earnings for the period under review. A dividend of 2½ per cent. was declared. The Directors elected were: Emerson McMillin, W. H. Doane, C. B. Firestone, D. E. Putnam, N. B. Abbott, P. H. Bruck, F. C. Hubbard, James Watson and Irvin Butterworth. The Directors subsequently named the following officers: President, Emerson McMillin; First Vice President and General Manager, Irvin Butterworth; Second Vice President, D. E. Putnam; Secretary and Treasurer, A. P. Lathrop; Assistant Secretary and Treasurer, C. L. Horton.

A MORTGAGE of $1,500,000, covering all the properties of the Atlanta (Ga.) Gas Light Company, has been filed. The bonds are of the par value of $1,000 each, are payable in 50 years, in gold, and bear 5 per cent. interest.

WE understand that the Battleboro (Vt.) Gas Light Company will furnish electric power to the local trolley railroad.

A PHILADELPHIA correspondent forwards the following: "Mr. William Rennyson, Treasurer of the Spring City and Royersford (Pa.) Gas Light Company, has filed a bill in equity against Ambrose P. Cox, of Royersford, restraining the defendant from collecting or levying upon the plant of the Company for county, borough and school taxes. The petition of the plaintiff Company sets forth that the Company is the owner of 1½ acres of land in Royersford, on which is erected its generators, holders and other appurtenances, and that the Company has pipes distributed through Spring City and Royersford. It is further stated that last year the plant of the Company was returned by the assessor of Royersford for the purpose of local taxation at a valuation of $2,800, whereupon the County Commissioners levied a tax of $5.60, the Borough Council $18.20, and the school district a tax of $16.80; that the tax duplicate of 1894 was delivered to the defendant, the tax collector of the Borough, and that he forthwith proceeded to collect these taxes and demanded payment thereof, and upon being refused threatened and declared his intention of collecting and recovering the taxes, with 3 per cent. penalty delinquency; that the plaintiff being a stock company and has paid for 1894 the State tax on it capital stock, in which the real estate is included, and that the capital stock is owned by individuals who are liable to pay thereon whatever further taxes, if any, are due from the Commonwealth, county, Borough or school district; and, furthermore, that as the realty is necessary for the chartered purposes of the Company and is included in the capital stock on which State tax is paid; that the realty is not liable to assessment nor chargeable with other than State taxes."

THE Berlin Iron Bridge Company, of East Berlin, Conn., is putting up an iron bridge at Thomaston, Conn., consisting of two plate girder spans, each 60 feet long, with a roadway 22 feet wide, and two sidewalks, each 6 feet wide. The bridge will be made of iron and concrete, no woodwork being used in the construction.

WILMINGTON, Del., has an official inspector of plumbing whose name is E. F. Kane. He is obliged to submit an annual report of the working of his special department, and, take it by and large, he seems to be a rather competent official and is not afraid to speak his mind. In his report for last year he avers that cases of indifferent work on the part of gas fitters are far too frequent in Wilmington; in fact he goes so far as to say: "There can be no question that the manner in which most of the gas fitting is done is not proper, either as regards the sizes of the pipes or the testing of the same, wherefore much gas is lost to consumer, for which loss the gas suppliers are frequently blamed."

WE understand that Mr. C. W. Blodget's term as "Manager" of the Williamsburg Gas Light Company, of Brooklyn, N. Y., is almost at an end. "All's well that ends well."

IN the meantime, Col. Benson, of the Nassau Company, also of Brooklyn, N. Y., is enjoying good health.

THE lava gas tips manufactured by the D. M. Steward M'f'g Company, of Chattanooga, Tenn., are rapidly displacing in the American market all foreign makes, and it is right that this should be the case, for the Steward tip is superior to anything of the sort made in Germany or France. The Company has been obliged to more than double the capacity of its gas tip plant, and its finished output for the past 12 months was four times larger than the output for the year immediately preceding.

THE Borough Council, of Coatesville, Pa., recently passed an ordinance making it unlawful for any person or corporation to keep within the town's limits more than 25 gallons of explosive liquids. This ordinance, of course, affected the Gas Company, but the Council subsequently amended the rule to the extent of exempting the Company from its operation until it could perfect storage apparatus for its enriching oils that would be an insurance against danger from them.

MRS. SARAH T. RORER'S third "Demonstration lecture on cooking by gas," under the auspices of the Consolidated Gas Company, was given in Madison Hall, corner of Madison avenue and 125th street, on the afternoon of April 23d. The lecturess, who was in excellent voice, spirit and method, kept her large audience thoroughly interested for an hour and a half, which was about the time taken up in the "demonstration." A like criticism or verdict also applies to the fourth lecture of the series, which was also delivered in Madison Hall, on the afternoon of the 3rd inst.

THE following is the text of the decision of the Court of Errors and Appeals of the State of New Jersey in the matter of certain long-term contracts for public lighting in Jersey City—we believe that the opinion was written by Chancellor McGill:

The Board of Street and Water Commissioners of the City of Jersey City are required to advertise for proposals for contracts for street lighting, where the expenditure is to exceed $500, stating approximately at least, the amount or extent of the lighting to be done under the contract contemplated. The second section of the act of May 1, 1894 (P. L. 170), does not validate contracts made in disregard of the requirements of such advertisement. Board of Finance of Jersey City vs. the Mayor and Alderman of Jersey City, the United Gas Improvement Company, the Jersey City Gas Light Company, the Consumers' Gas Company, the People's Gas Light Company and others. On error to the Supreme Court. Mr. Charles L. Corbin, for the Board of Finance of Jersey City. Mr. Flavel McGee for the Gas Light Companies. Mr. W. D. Edwards for the Mayor and Alderman of Jersey City. The Chancellor. The writs of error bring up for review five judgments of the Supreme Court touching the legality of five seperate contracts for street lighting in the city of Jersey City—one contract for electric lighting, another for lighting by oil and the other three for lighting by gas. The first two named were sustained as valid by the Supreme Court, but the three gas lighting contracts were set aside because they extended for a longer period than five years, which was the maximum term limited by law, for such a contract. We concur in the conclusions of the Supreme Court, upon which the three gas lighting contracts were set aside. That court did not express an opinion upon the question of the regularity of the advertisements for proposals for the contracts in question. By the 159th Section of the "Act to reorganize the local government of Jersey City," approved March 31, 1871 (P. L. 1871, p. 1160), it is provided that no contract for work or materials, requiring an expenditure of more than $500, shall be entered into by any board or department of the city government, except after due advertisement for six days, at least, in official newspapers. By the 27th section of a supplement to that act, approved March 24, 1873 (P. L. 1873, p. 407), it is provided that all advertisements for proposals for doing work or furnishing materials shall contain an approximate estimate of the amount of the various kinds of work or materials required. By the 14th section of the act approved March 28, 1891 (P. L. 1891, p. 33), which creates for cities of the first class Boards of Street and Water Commissioners and defines their powers and duties, the provision of the charter of Jersey City, above referred to, became applicable to the Board of Street and Water Commissioners of Jersey City. We think that by force of this legislation the Board of Street and Water Commissioners of Jersey City was required to advertise for proposals for contracts for the street lighting in question, and approximately, at least, state the amount or extent of the lighting which each proposed contract would require. That Board did advertise for proposals for lighting and did indicate the several sections of the city to be lighted by the several contracts, but failed to state approximately or otherwise, either the number of lamps to be lighted or the length of time for which the proposed contracts were to continue. The advertisement referred to specifications on file in the office of the Clerk of that Board, but those specifications did not intimate how long the contracts were to run, nor, except in the case of the contract for lighting with oil, how many lamps were to be lighted. It is true that by going through the districts indicated in the advertisement it was possible for a bidder to estimate the number of lamps, but that it was not within the meaning of the law that such a deterrent task should be imposed, is conspicuous. The express requirements of the statute is that the estimate shall appear in the advertisement. But be this as it may, as the length of the term to be delivered by the proposed contracts was not stated, the value of the contracts remained undisclosed and incapable of being ascertained. It is apparent that the tendency of the announcement of long contracts would have been to induce competition, because of the encouragement such contracts would offer capital to embark in the enterprise they would present. We think that the advertisements were not in compliance with the requirements of the statute, and that the defect in the proceedings in this respect is fatal to all the contracts. The attention of the Court has been directed to the act of the Legislature, approved May 1, 1894, entitled "An Act relative to the lighting of streets, roads and public places in this State" (P. L. 170), the second section of which provides that any contract theretofore entered into by any city for the lighting of public streets, roads or public places thereof, for any period, not exceeding 10 years, shall be as valid and effectual as if the same had been entered into and made pursuant to legislative authority "for such term," and it is insisted that thereby the contracts in question have been legalized. But it is deemed that that act does not, by its terms, validate any of the contracts against the objection that the proposals for them were not advertised in accordance with the requirements of law. It is noted, in the language of the statute, that the only defect contemplated and waived is in the length of the term of the contract. The provision is, that where a contract has been entered into for less than ten years, it is to be as valid and effectual as if it had been entered into, pursuant to legislative authority, for its term. As has been seen, the law authorized the contracts only after due advertisement for proposals for them, without which they were not entered into, pursuant to legislative authority for any term. That serious non-compliance with the law has not been waived. Taking this view of the meaning of the act of 1894, it is not necessary to our conclusion to pass upon the insistment that the act is within the constitutional inhibition of a special law to regulate the internal affairs of the city, upon the ground that such contracts as that in question are of necessity replete with covenants and terms which are applicable only to the contracting parties, of whom a city is one, and consequently, their establishment by retrospective enactment must result in a special regulation of internal affairs of that city. I am strongly inclined to the opinion that the proposition is entirely sound. It appears to me that to hold otherwise would open a way whereby the constitutional provisions invoked might with ease be stripped of its salutary effect. Indeed, I fail, now, to perceive any process of reason by which a subsequent legislative waiver of a single fatal defect in such a contract can be regarded otherwise than as within the constitutional interdiction. Our conclusion is that all the contracts are invalid and that the judgments which sustain two of them must be reversed and that the judgments which set aside the other three must be affirmed.

THE AMERICAN GAS LIGHT JOURNAL

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MONDAY, MAY 6, 1895.

Amylotryose—A New Sugar.

At a recent meeting of the Chemical Society in London, A. R. Ling and J. L. Baker read a paper in which they stated that they had examined the hydrolytic products of starch when acted on by diastase. The diastase was obtained from different sources and prepared by different methods. The authors confirmed the previous results recorded by Brown and Morris, since they obtained maltodextrin, the physical constants of which were determined and found to agree with those given by Brown and Morris. "Isomaltose," another product of the hydrolysis of starch, was also isolated, and the osazone on examination possessed the same melting point as that recorded by Lintner. The isomaltose was purified by crystallization and precipitation from methylic alcohol solution by absolute alcohol. The isomaltose thus obtained agreed in these respects with that obtained by Lintner, but on treatment with sodium acetate and acetic oxide, a mixture was obtained from which octacetyl-maltose was separated and identified. The isomaltosazone was also proved to be a mixture, since maltosazone was separated and identified. Further experiments on the action of diastase and the determination of its reducing power showed that isomaltose is not a homogeneous substance, but a mixture of maltose with probably two other substances. One of these was separated, and from examination of the osazone is probably a new sugar—$C_{18}H_{32}O_{16}$—for which the name amylotryose is proposed. The other substance present in isomaltose appeared to be a dextrin, which, however, was not identified. H. Brown, F.R.S., stated that experiments in progress in his laboratory confirmed the conclusions recorded above as to the non-homogeneity of isomaltose so far as that it was not a pure substance nor an isomer of maltose. Dr. Kipping suggested that a better name for the new sugar would be triamylhexose.

Novel Antiseptics.

Several of our most powerful and popular antiseptics, *e. g.*, carbolic acid and nitrate of silver, lose part of their effect when admixed with substances containing albumenoids, because they coagulate the albumen and are precipitated with them. The result is that we have to apply an excess of the antiseptic, which means waste, and which may be objectionable in so far as such more concentrated solutions may prove corrosive or toxic. Under these circumstances a discovery made by the Chemische Fabrik auf Aktien, late E. Schering, Berlin, has a wider interest. There are certain organic bases, in themselves poisonous to the lower organisms, which, when combined with these antiseptics, prevent coagulation of the albumen, and, moreover, render the agent more effective. These bases, ethylenediamine and its derivatives, contain compounds derived from the chlorohydrines, etc., are all highly alkaline, and capable of dissolving the membranes of some bacilli, hence their increased efficiency. The mode of preparation is simple. About 10 lbs. of the base are dissolved in 500 lbs. of water, and the antiseptic, freshly distilled cresol, for instance, gradually added. Creosote and other antiseptics require a little more of the base. To prepare the silver compounds, we proceed in a similar way, starting from phosphate or nitrate of silver, or other organic silver salts, or even the chloride of silver. These novel silver compounds dissolve mucus, and may be diluted according to requirements; they are thus very convenient for use. Among the antiseptics which may be treated in this manner are carbolic acid, cresol, thymol, naphthol, guajacol, creosote, etc., and further silver compounds.

The Market for Gas Securities.

Consolidated sold above 140 to day (Friday), and the indications are that higher prices are to rule in it. We wish simply to reiterate the advice that we have given in previous issues regarding the advisability of purchasing the stock. New York and East River common is in some demand, and 26 is freely bid for it. Standard is a shade easier as to the preferred. Mutual is very strong, at 159. The Company is about to expend a large sum (out of surplus) in plant enlargement, the chief betterment being a gasholder of over 4 million cubic feet capacity. Brooklyn shares are unchanged. Chicago gas is again on the up grade, the new management of the Company seemingly having gained the confidence of investors. Consolidated, of Baltimore, is 64 bid, Bay State has advanced to 21⅛, bid, and Laclede common is strong, at 28¼. At auction: $3,000 Lockport (N.Y.) Gas and Electric Light 6's, due 1914, at 97½; and 449 shares Fostoria (O.) Light and Power Company, at $130 for the lot.

Gas Stocks.

Quotations by Close & Nash, Brokers and Dealers in Gas Stocks,
35 WALL ST., NEW YORK CITY.
MAY 6.

☞ All communications will receive particular attention.
☞ The following quotations are based on the par value of $100 per share.

N. Y. City Companies.	*Capital.*	*Par.*	*Bid.*	*Asked.*
Consolidated	$35,490,000	100	140	141
Central	500,000	50	140	..
" Scrip	220,000	..	100	..
Equitable	4,000,000	100	188	187
Bonds, 6's	1,000,000	1,000	105	107½
" 1st Con. 5's	2,300,000	1,000	112½	..
Metropolitan Bonds	658,000	..	108	112
Mutual	3,500,000	100	159	..
" Bonds	1,500,000	1,000	100	102
Municipal Bonds	750,000	..	..	..
Northern	150,000	50	..	..
" Bonds	150,000	..	..	98
New York and East River	5,000,000	100	26	28
Preferred	2,000,000	100	45½	48
Bonds	3,500,000	1,000	84	85
Richmond Co., S. I.	348,650	50	50	..
" Bonds	100,000	..	..	..
Standard	5,000,000	100	47	48½
Preferred	5,000,000	100	97½	100
Bonds, 1st Mortgage, 5's	1,500,000	..	101	..
Yonkers	.....	50	101x	.
Gas Co's of Brooklyn.				
Brooklyn	2,000,000	25	125	..
Citizens	1,200,000	20	65	..
" S. F. Bonds	330,000	1,000	..	101
Equity	2,000,000	10	..	..
" Bonds	1,000,000	..	..	..
Fulton-Municipal	3,000,000	100	175	..
" Bonds	800,000	..	103	..
Peoples	1,000,000	10	90	.
" Bonds, 7's	308,000	..	100	..
" " 6's	94,000	..	98	100
Metropolitan	870,000	100	170	..
" Bonds, 5's	70,000	..	..	..
Nassau	1,000,000	25	200	..
" Ctfs.	700,000	1,000	99	100
Williamsburgh	1,000,000	50	200	..
" Bonds	1,000,000	..	107	110
Out-of-Town Companies.				
Bay State	5,000,000	15	21¾	22½
" Income Bonds	2,000,000	1,000	19½	20
Boston United Gas Co.—				
1st Series S. F. Trust	7,000,000	1,000	77¼	78
2d " " "	3,000,000	1,000	57	58
Buffalo Mutual	750,000	100	120	..
" Bonds	200,000	1,000	95	100
Chicago Gas Co.	25,000,000	100	75⅝	75¾
Chicago Gas Lt. & Coke Co. Guaranteed Gold Bonds.	7,650,000	1,000	93	93½
Columbus	1,000,000	..	..	..
1st Mortgage	1,085,000	..	..	..
Consumers, Jersey City	2,000,000	100	72	76 x
" Bonds	600,000	1,000	97	100 x
Cincinnati G. & C. Co.	7,000,000	100	..	208½
Consumers, Toronto	1,600,000	50	184½	187
Central, San Francisco	.....	..	90	100
Capital, Sacramento	.....	..	..	50
Consolidated, Baltimore	11,000,000	100	64	64½
Mortgage, 6's	3,600,000	..	107	107½
Chesapeake, 1st 6's	1,000,000	..	..	..
Equitable, 1st 6's	910,000	..	..	..
Consolidated, 1st 5's	1,490,000	..	..	..
Detroit	4,000,000	..	20	24
" Con. Bonds	4,312,000	..	..	..
Equitable Gas & Fuel Co., Chicago, Bonds	2,000,000	1,000	..	101
Fort Wayne	2,000,000	..	74½	76½
" Bonds	2,000,000	..	83	85
Hartford	750,000	25	120	128
Indianapolis	2,000,000	..	139	143
" Bonds, 6's	2,650,000	..	101¾	103 x
Jersey City	750,000	20	195	..
Lafayette Gas Co., Ind.	1,000,000	100	85½	88
Bonds	1,000,000	1,000	87	90
Louisville	2,570,000	50	..	130
Laclede, St. Louis	7,500,000	100	28¼	28½
Preferred	2,500,000	100	84	86
Bonds	9,084,400	1,000	93½	94
Little Falls, N. Y.	50,000	100	..	100
Bonds	25,000	..	..	100
Montreal, Canada	2,000,000	100	200	208
New Haven	.....	25	200	..
Oakland, Cal.	.....	..	43⅝	43
Peoples Gas Lt. & Coke Co., Chicago, 1st Mortgage	2,100,000	1,000	..	108
2d "	2,500,000	1,000	104	105
Peoples, Jersey City	500,000	50	165	175
Paterson, N. J.	.....	25	99	102
Rochester Gas & Elec. Co.	2,150,000	50	..	..
Preferred	2,150,000	50	81	..
Consolidated 5's	2,000,000	..	87½	90
Syracuse, N. Y.	500,000	25	..	..
San Francisco, Cal.	10,000,000	100	72⅜	72¾
Washington, D. C.	2,000,000	20	250	..
Western, Milwaukee	4,000,000	100	55	58
Bonds, 5's	3,556,000	..	84½	85½
Wilmington, Del.	500,000	50	188	190

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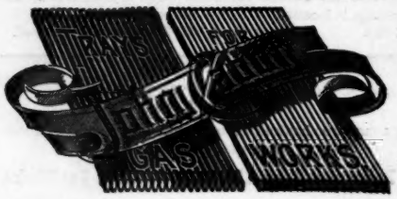

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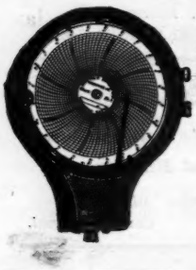

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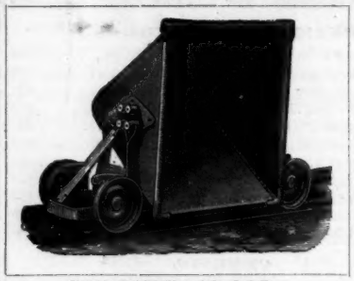

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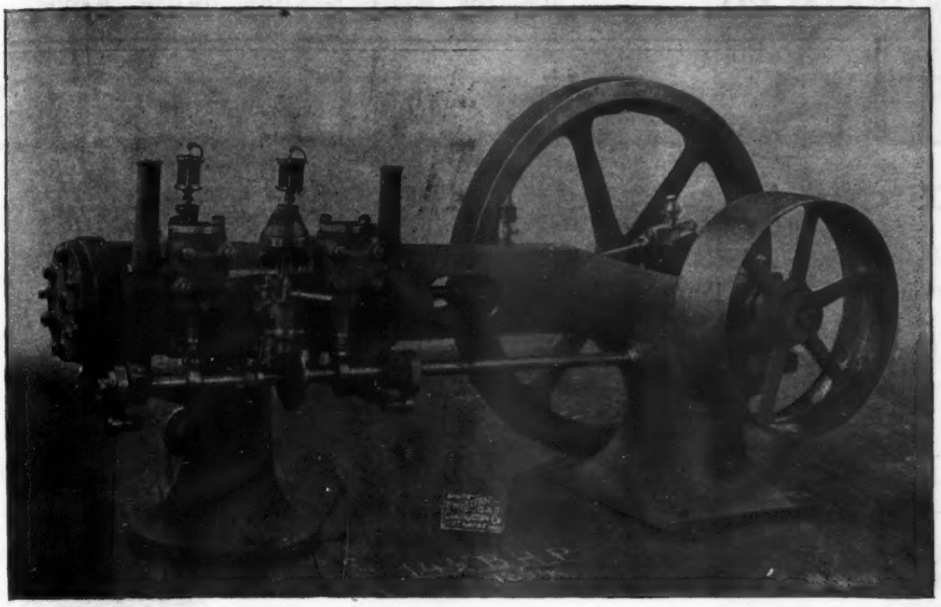

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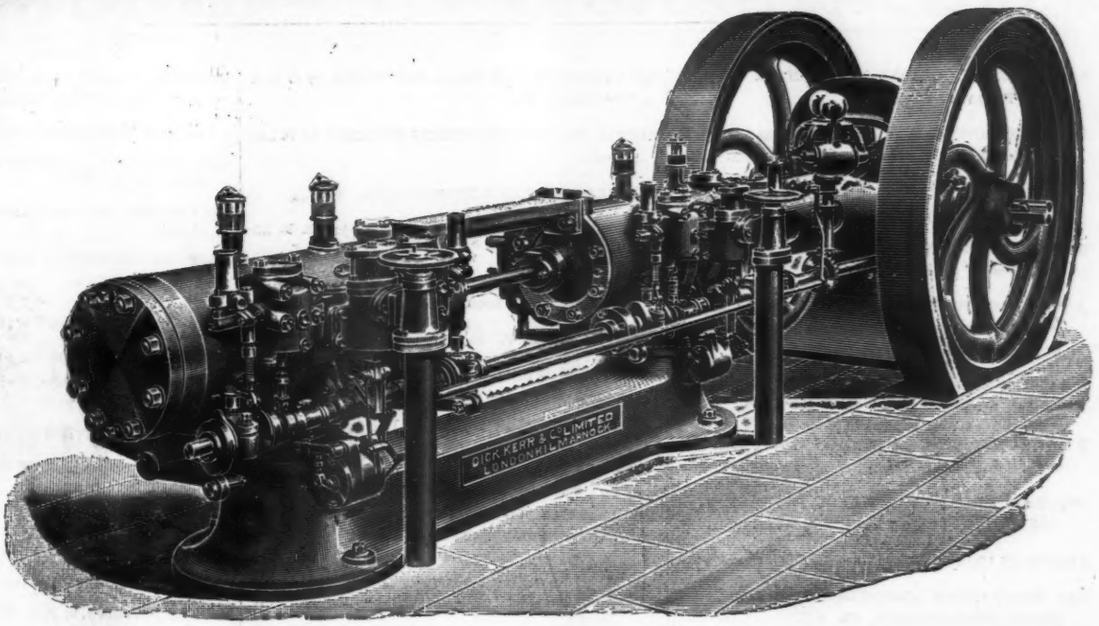

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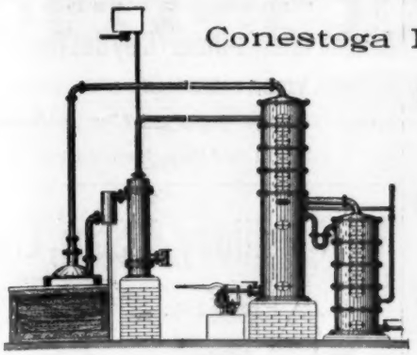

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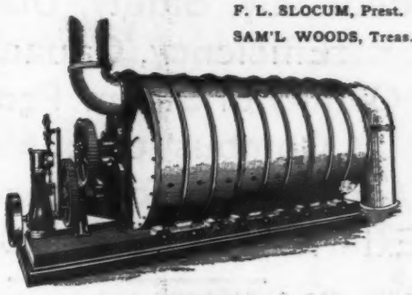

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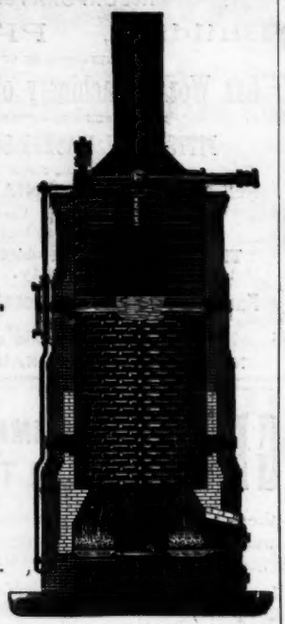

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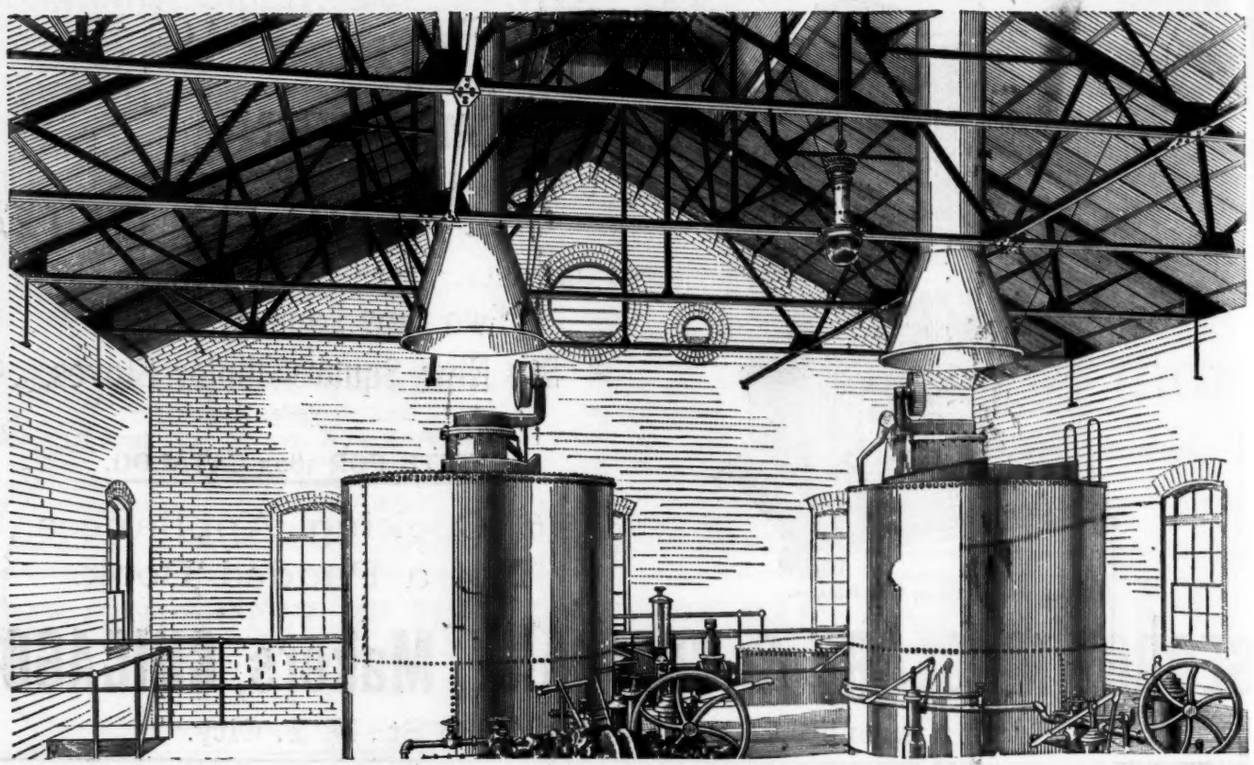

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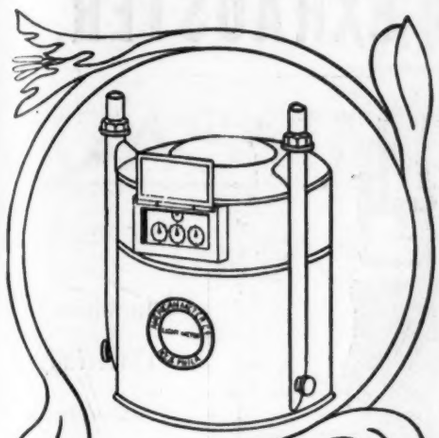

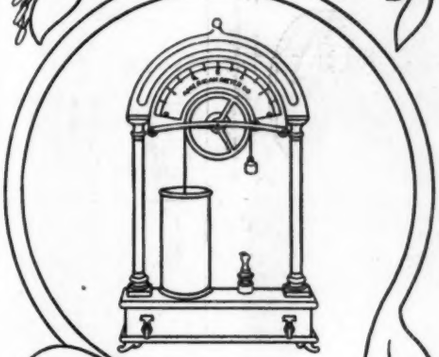

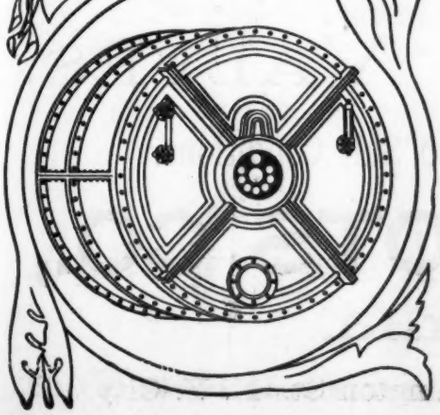

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SAN FRANCISCO.

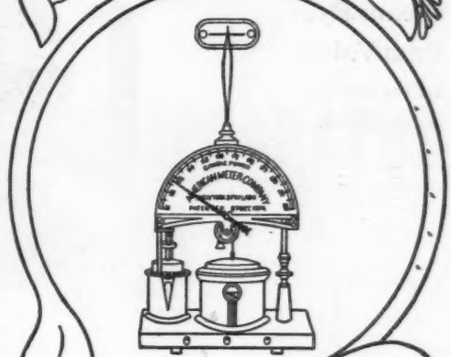
PUBLIC LIGHTING TABLE.

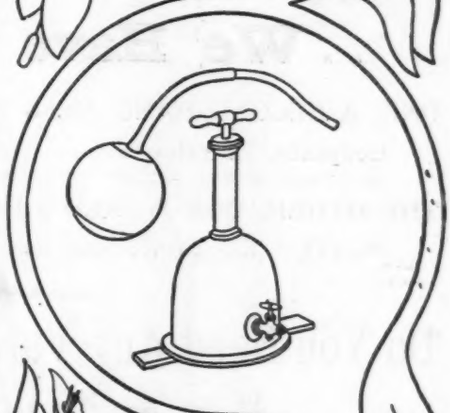
MAY, 1895.

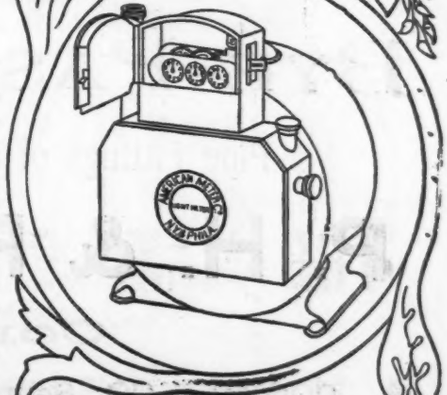
Day of Week.	Table No. 1. Following the Moon.			Table No. 2. New York City. All Night Lighting.	
	Date.	Light.	Extinguish.	Light.	Extinguish.
				P.M.	A.M.
Wed.	1	12.40 AM FQ	4.00 AM	6.45	4.00
Thu.	2	1.10	4.00	6.45	4.00
Fri.	3	1.30	4.00	6.45	4.00
Sat.	4	2.00	4.00	6.45	4.00
Sun.	5	2.20	3.50	6.45	4.00
Mon.	6	2.50	3.50	6.45	4.00
Tue.	7	No L.	No L.	6.55	3.40
Wed.	8	No L. FM	No L.	6.55	3.40
Thu.	9	No L.	No L.	6.55	3.40
Fri.	10	7.30 PM	10.30 PM	6.55	3.40
Sat.	11	7.30	11.30	6.55	3.40
Sun.	12	7.40	12.20 AM	6.55	3 40
Mon.	13	7.40	1.00	6.55	3.40
Tue.	14	7.40	1.30	7.00	3.30
Wed.	15	7.40	2.00	7.00	3.30
Thu.	16	7.40 LQ	2.20	7.00	3.30
Fri.	17	7.40	2.40	7.00	3.30
Sat.	18	7.40	3.00	7.00	3.30
Sun.	19	7.40	3.20	7.00	3.30
Mon.	20	7.40	3.40	7.00	3.30
Tue.	21	7.40	3.40	7.10	3.15
Wed.	22	7.40	3.40	7.10	3.15
Thu.	23	7.40	3.40	7.10	3.15
Fri.	24	7.40 NM	3.40	7.10	3.15
Sat.	25	7.40	3.40	7.10	3.15
Sun.	26	7.50	3.30	7.10	3.15
Mon.	27	7.50	3.30	7.10	3.15
Tue.	28	7.50	3.30	7.15	3.15
Wed.	29	11.10	3.30	7.15	3.15
Thu.	30	11.40 FQ	3.30	7.15	3.15
Fri	31	12.00	3.30	7.15	3.15

TOTAL HOURS LIGHTING DURING 1895.

By Table No. 1.	Hrs. Min.	By Table No. 2.	Hrs. Min.
January	237.00	January	423.20
February	196.40	February	355.25
March	195.50	March	355.35
April	165.30	April	298.50
May	153.40	May	264.50
June	138.20	June	234.25
July	146 30	July	243.45
August	152.50	August	280.25
September	165.10	September	321.15
October	186.10	October	374.30
November	204.10	November	401.40
December	219.30	December	433.45
Total, yr.	2161.20	Total, yr.	3987.45







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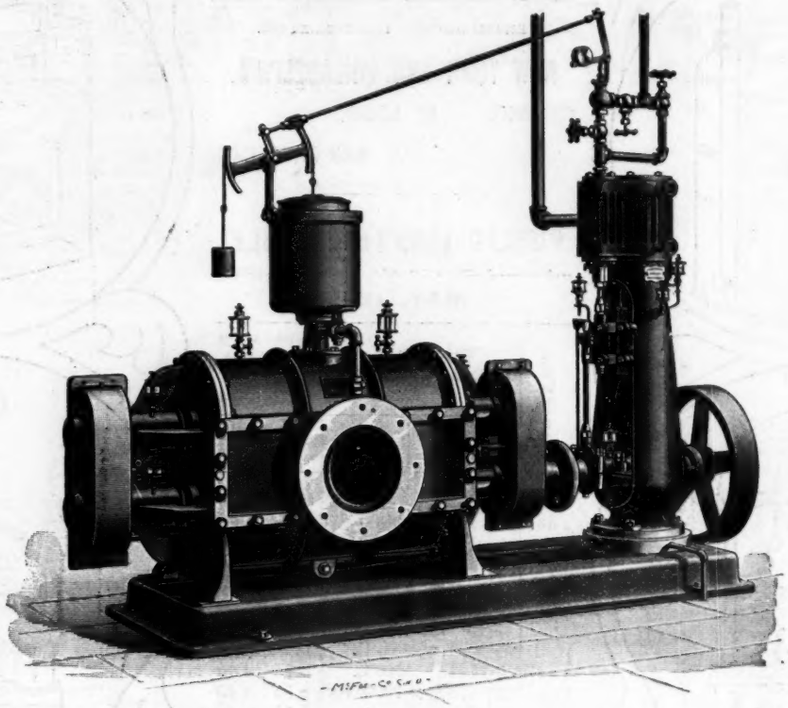

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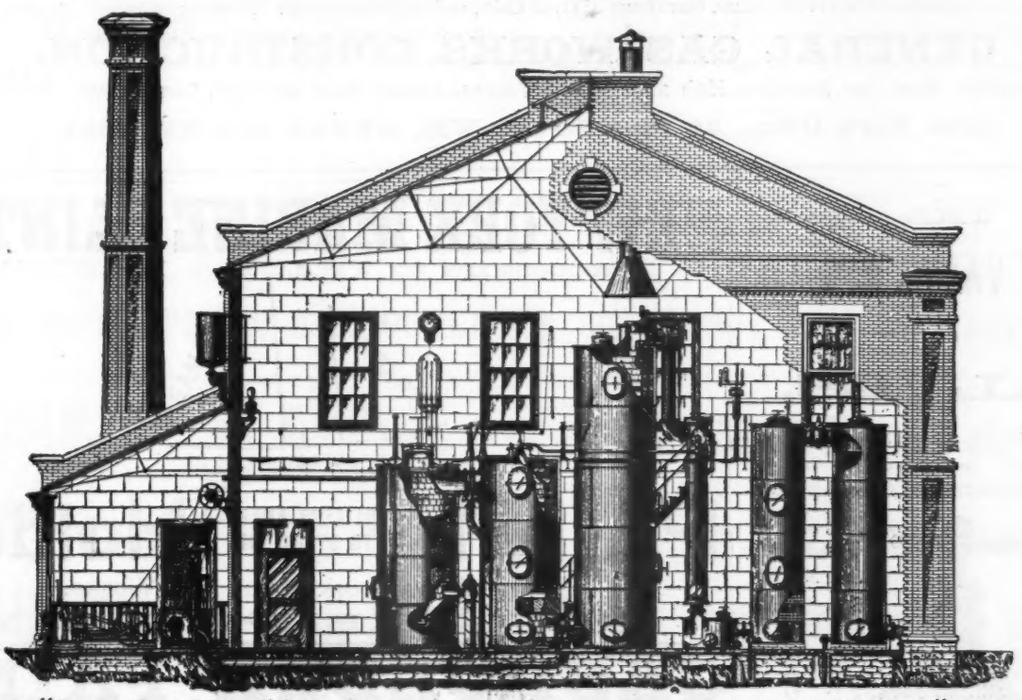

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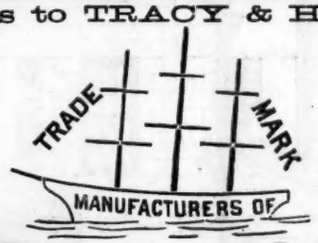

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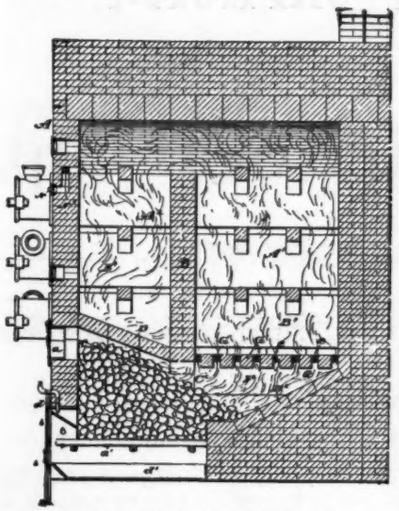

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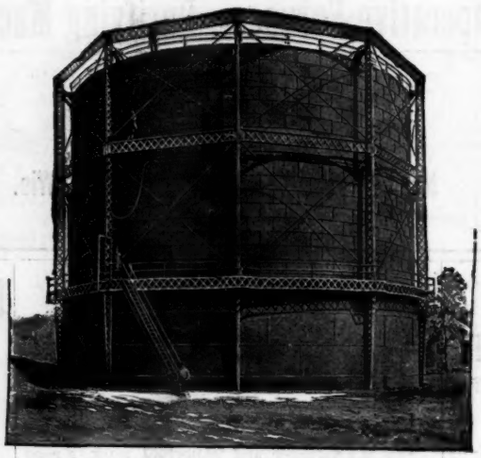

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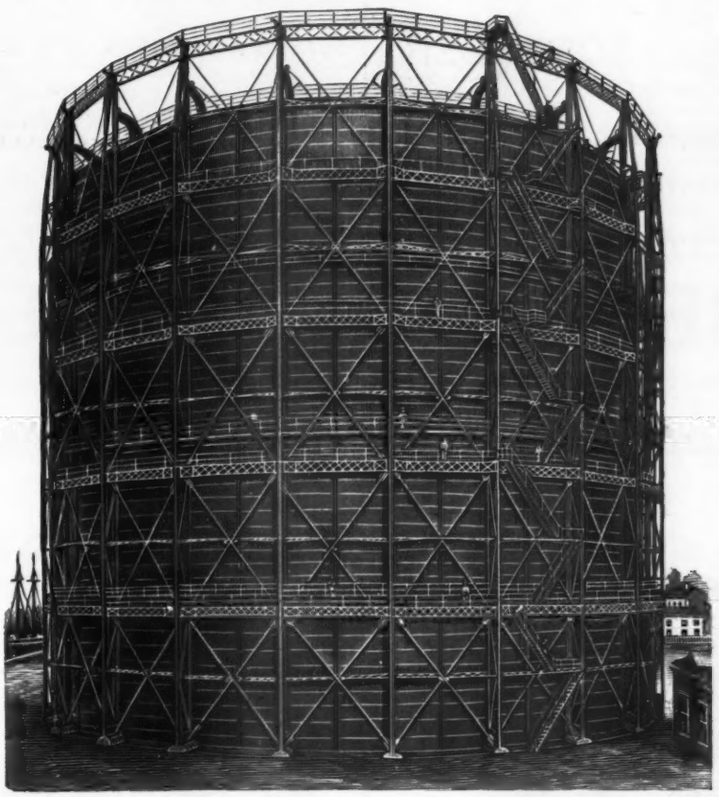

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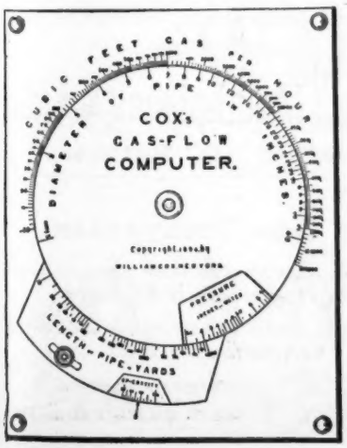

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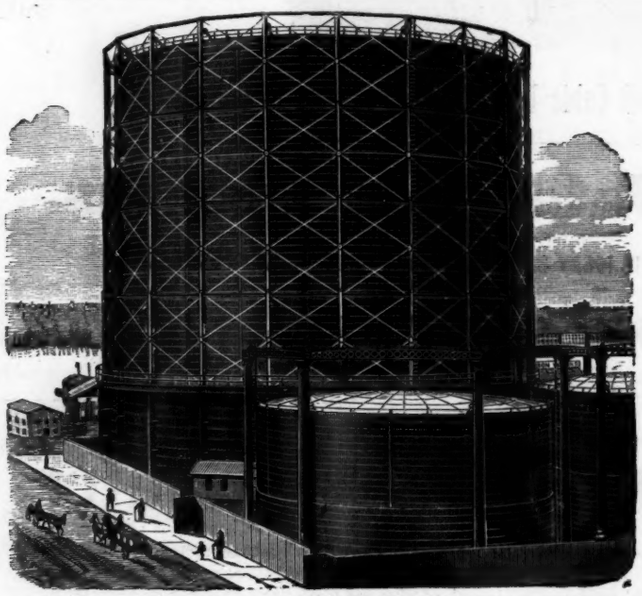

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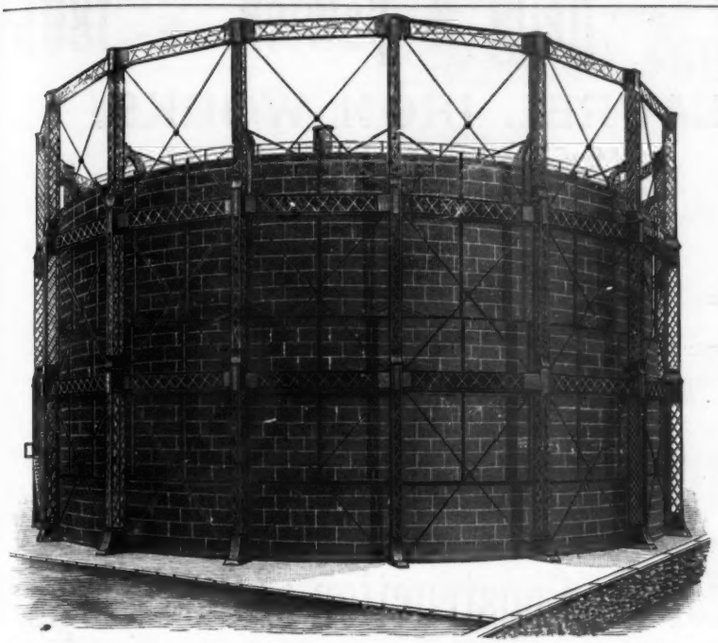

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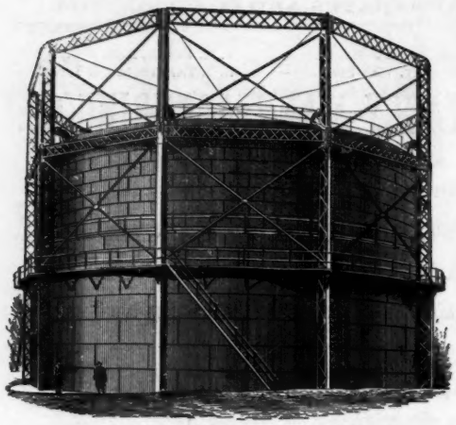

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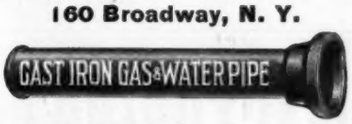

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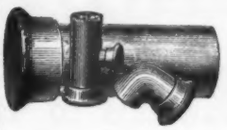

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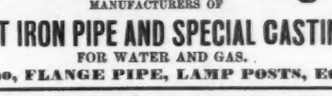

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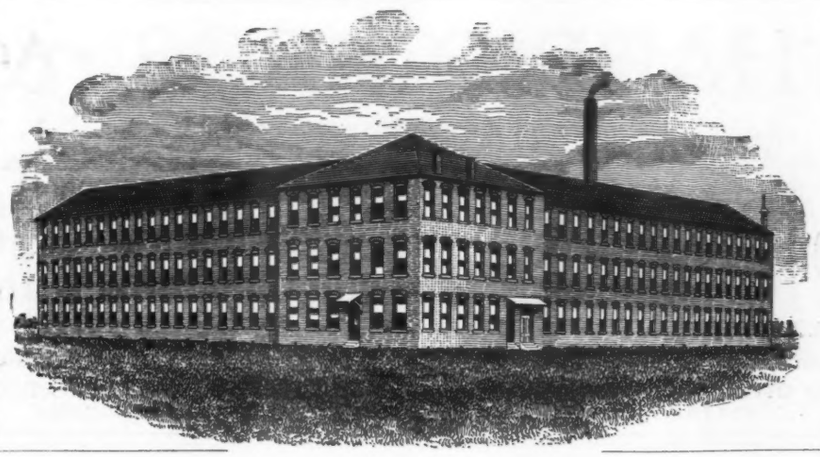

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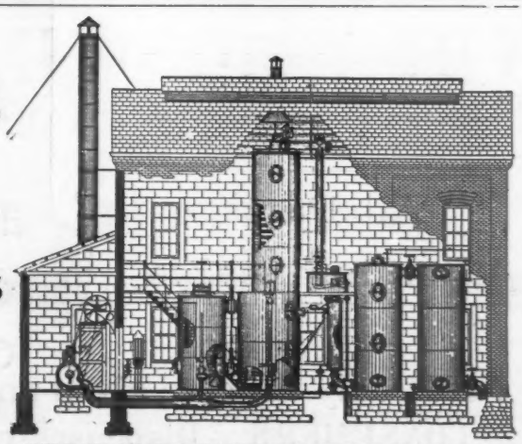

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